User Manual

PAC-F100 (Feeder Protection and Control Unit)

P&C Technologies Co., Ltd.

Safety Caution

It is contents to keep away user's safety and damage of property.
Use rightly after read manual attentively certainly.
Manual will be kept in place that a person who use product can see well.

Caution : Not following the instruction may result in serious injury or even death

Danger : Not following the instruction may result in serious injury or property damage

REVISIONS

REV	Date	Description/Reason
1	July 10, 2009	1st English translation

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1 Overview

PAC-F100 is multifunction relay that have all functions, protection, control and monitoring. This relay is available by backup protection, control and monitoring of distribution line, transmission line and transformer irrelatively to grounded system(earthed network, unearthed network and resistance earthed network etc.) of system, and to distribution power-system because has directional detection element applicable.

PAC-F100 has various measuring and monitoring function such as quantity of electricity measure, self-diagnosis, current input circuit monitoring, current/voltage unbalance monitoring, PT fuse monitoring and Trip Circuit Supervision (TCS).

PAC-F100 has four setting groups for protection, and change and apply setting group according to system driving condition change and enables optimum protection. This relay can be various and designs economically trip logic, inter-lock sequence and lock-out function without external addition logic or connection by programmable logic(Easy-Logic).

Event and waveform recording function of PAC-F100 offer driving history of necessary data and device to fault analysis. PAC-F100 has event and waveform recording data that is stored even if control power is lost. Stored recording can analyze in PC after upload using front communication port in integration PC program (PACManager^{TM}).

If min/max value is inputted through analog input, MIN/MAX recording function of PAC-F100 is recorded quantity of electricity by primary value with inputted time, and recording is kept even if control power is lost.

PAC-F100 has 8 basic LEDs and 8 user setting LEDs, and offers convenient menu-tree through graphic LCD, and relay and circuit breaker can be controlled by keypad.

There is one RS-232 port on front of PAC-F100 that can communicate with PC program (PACManagerTM), and are two RS-485 ports on rear of PAC-F100 can connect with remote monitoring system. This relay provides ModBus, DNP3.0 and IEC 60870-5-103 protocol for communication with remote monitoring system.

1.1 Characteristics

- Digital line Protective Relay that use two processors
- Use possibility by backup protection, control and monitoring of distribution line, transmission line and transformer
- 4 protection element setting groups
- Eighteen protection element : OCR, OCGR, SGR, Thermal Overload, UCR, NSOCR, UBOCR, OVR, UVR, OVGR, NSOVR, FREQ, AREL, CBF, PHS DIR, GND DIR, COLD LD, INRUSH
- Various TC curves : IEC standard, ANSI standard, KEPCO induction type, P&C curve
- Control of CB open/close on local and remote mode
- Metering : 3-phase current/voltage, Sequence current/voltage, 3 phase real /reactive /apparent power, Energy, Frequency, Power factor, Thermal, THD(Total Harmonic Distortion) and harmonic size (to 31 harmonic waves), Demand current, Three phase demand real/reactive/apparent power, Reclosing count
- Event recording upto 1024 and maximum 8 fault waveform recording (64 samples/cycles)
- Quantity of electricity MIN/MAX recording : Line to line voltage, Voltage/current by a phase, Three phase real/reactive/apparent power, Three phase power factor, Demand current by a phase, Three phase demand real/reactive/apparent power, Frequency
- Engineering tool : Setting change, Event inquiry, Fault waveform analysis
- Graphic LCD (240 × 128, 16line × 30character) : Single line diagram, tree structure menu, 16 LEDs, 11 Keypad button
- Communication port : Front interface RS232 1 port (ModBus Protocol : Setting change, Event/Fault waveform transmission, measuring monitor), Rear interface RS485 2 ports (SCADA communication, DNP3.0/ModBus/IEC60870- 5-103 protocol)
- Self-diagnosis function : DC power supply, Memory, CPU, Setting range, DSP, A/D converter, Analog input circuit, inside logic element and digital input/output circuit
- Five monitoring functions : PT Fuse failure monitoring(PT Fuse failure), Current input circuit monitoring(Current Sum), Voltage unbalance monitoring(Voltage Balance), Current unbalance monitoring(Current Balance), Trip circuit (TCS) monitoring function
- Eight user setting LEDs
- Panel design easiness in sequence logic structure through EasyLogic Editor
- Test function : Output relay and front display department
- Software upgrade easiness by flash memory use
- Flexible control source (option : AC 110 ~ 240 V, DC 19 ~ 130 V)
- Access Security by password for settings and CB control

1.2 Application

- Backup protection/control/monitoring of distribution line, transmission line and transformer

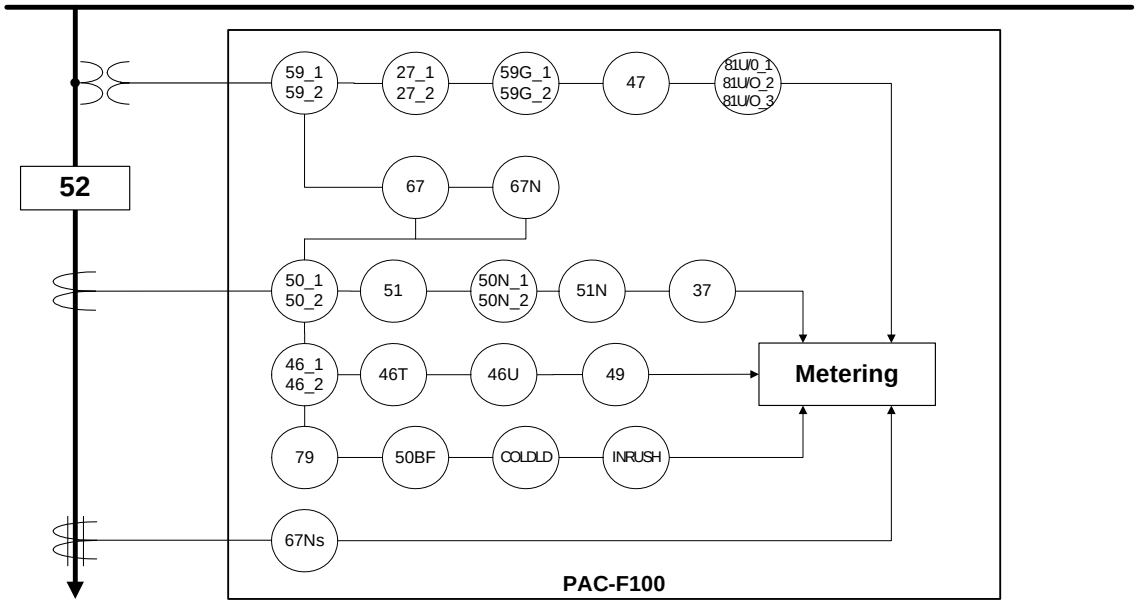


Figure 1-1 Function single line diagram

Table 1-1 Device/Function

Device	Function
59_1, 59_2	Overvoltage Protection
27_1, 27_2	Undervoltage Protection
59G_1, 59G_2	Residual / Ground overvoltage Protection
47	Negative sequence overvoltage Protection
81U/O_1, 81U/O_2, 81U/O_3	Under/overfrequency Protection
67	Phase direction detection
67N	Ground direction detection
50_1, 50_2	Instantaneous/Definite time short overcurrent Protection
51	Inverse short overcurrent Protection
50N_1, 50N_2	Instantaneous/Definite time ground overcurrent Protection
51N	Inverse ground overcurrent Protection
37	Undercurrent Protection
46_1, 46_2	Instantaneous/Definite time negative sequence overcurrent Protection
46T	Inverse negative sequence overcurrent Protection
46U	Current unbalance(Phase open) Protection
49	Thermal overload Protection
79	Auto Reclosing
50BF	Circuit breaker failure Protection
COLD LD	Cold Load Pickup
INRUSH	Inrush detection
67Ns	Sensitive directional ground overcurrent Protection

1.3 General Specification

1.3.1 Rated Control Power

Input	AC 110~220 V±20%(50/60 Hz), DC 80~300V, DC 19~130V * Normal operation duration in short-term power interruption is 100ms.
Power consumption	Below 30VA (Actually 15W)

1.3.2 Voltage

Rated voltage	AC 50~240.0V(50/60Hz)
Voltage range	1~450V
Overload capability	Continuous(~450V)
Power consumption	Below 0.5VA / phase

1.3.3 Current

Rated current	AC 5/1A (50/60Hz)
Current range	0.1 ~ 250A(In : 5A), 0.02 ~ 50A(In : 1A)
Overload capability	100×In for 1s, 20×In for 4s, 3×In for continuous
Power consumption	Below 0.5VA / phase

1.3.4 Binary outputs

Trip contact (6 Points(6A), Configurable)

Closed circuit capacity	16A / Continuous / AC 250V 30A / 0.3sec / DC 125V / Resistive load
Opened circuit capacity	5A / 0.1 (PF) / AC 250V 5A / 0.1 (PF) / AC 250V

Signal contact (10 Points(8A, 2C), Configurable)

Closed circuit capacity	5A / Continuous / AC 250V 5A / 0.3sec / DC 125V / Resistive load
Opened circuit capacity	1A / 0.1 (PF) / AC 250V 1A / 25ms (L/R Time constants) / DC 125V

1.3.5 Binary inputs

Number	16, Configurable
Voltage range	Maximum DC 250V
On/Off threshold voltage	DC 19~130V: Von ≥19V, Voff ≤14V DC 80~300V: Von≥80V, Voff ≤60V
Recognition time	Less than 10ms

1.3.6 Communication Interface

Front Panel	RS-232 (for PACManager™)
	19200bps(fixed), 8bit/No parity/1 stop
	Modbus Protocol
Rear Panel	2 Galvanic isolated (for SCADA communication)
	COM2 is Modbus exclusive use
	300 ~ 38400bps, 8bit/No parity/1 stop
	Modbus/DNP3.0/IEC60870-5-103 Protocol

1.3.7 Case

Structure	Draw-out type
Quality of the material	Fe
Weight	6.5kg
Terminal	U(spade)/Ring lug
	Inside diameter:5mm, Maximum outside diameter:12mm

1.4 Test

1.4.1 Insulation Tests

Insulation resistance

Standard	IEC60255-5, ANSI/IEEE 37.90.0
Detail Contents	500 V DC
Circuit – Case	10 MΩ
Circuit – Circuit	5 MΩ
Contact – Contact	5 MΩ

Insulation voltage withstand test

Standard	IEC60255-5, ANSI/IEEE 37.90.0
Detail Contents	For 1 minute (50/60 Hz)
Circuit – Case	2 kV
Circuit – Circuit	2 kV
Contact – Contact	1 kV

Impulse voltage withstand test

Standard	IEC60255-5, ANSI/IEEE 37.90.0
Detail Contents	Waveform : 1.2×50μs
	Permission counter : 3th each positive/negative polarity
Circuit – Case	5 kV
Transformer – Transformer	5 kV
Transformer – Control circuit	5 kV
Control circuit – Control circuit	3 kV
Contact – Contact	3 kV

1.4.2 Noise Test

1MHz burst disturbance

Standard IEC60255-22-1, ANSI/IEEE C37.90.1
Detail contents Oscillation frequency : 1 MHz
Voltage rise time : 75 ns
Repetition frequency : 400 Hz
Output impedence : 200 Ω
Permission method : Asynchronous
Polarity: Positive, Negative
Control power circuit : Common Mode 2.5 kV
Differential Mode 1.0 kV
Transformer : Common Mode 2.5 kV
Differential Mode 1.0 kV
Contact : Common Mode 2.5 kV
Differential Mode 1.0 kV

Fast transients / burst

Standard IEC60255-22-4 class Ⅳ, ANSI/IEEE C37.90.1
Detail contents Voltage rise time : 5 ns
50% peak voltage hold time : 50 ns
Repetition frequemcy : 2.5 kHz
Burst hold time : 15 ms
Burst period : 300 ms
Permission method : Asynchronous, Common- Mode
Polarity : Positive, Negative
Permission time : 1 min
Downtime : 1 min
Control power circuit : 4kV
Transformer : 4kV
Contact input/output : 4kV
Earth circuit : 4kV

Electrostatic discharge

Standard IEC60255-21-2 class Ⅱ
Detail contents Voltage polarity : Positive, Negative
Permission conter : 10
Permission interval : 1 sec
Permission region : Case
Air discharge: 8 kV
Contact discharge: 6 kV

Surge Immunity

Standard IEC60255-22-5 classⅣ

Detail contents Voltage waveform : 1.2×50 μs
Current waveform : 8×20 μs
Output impedence : 2 Ω
Permissin method : Asynchronous
Polarity : Positive, Negative
Permission counter : 3
Permission time interval : 30 sec
Control power circuit : Common Mode 4.0 kV
Differential Mode 2.0 kV
Transformer : Common Mode 4.0 kV
Differential Mode 2.0 kV
Contact circuit : Common Mode 4.0 kV
Differential Mode 2.0 kV

Radiated Susceptibility

Standard IEC60255-22-3 classⅢ, ANSI/IEEE C37.90.2

Detail contents Electric field intensity : 10 V/m
Permission frequency : 80MHz~1GHz
Frequency modulation : 1kHz sine wave 80% AM
Permission direction : Front, Rear
Antenna direction : Verticality, horizontality
Dwell time: 1sec

Line Conducted HF

Standard IEC 61000-4-6 classⅢ

Detail contents Permission frequency : 150kHz ~ 80MHz
Electric field intensity : 10 V
80% AM, 1kHz

1.4.3 Mechanical Test

Vibration

Standard IEC60255-21-1 classⅡ

Detail contents Vibration frequency : 16.7Hz
Amplitude of vibration : 0.4mm
Vibration direction : Front, Rear / Left, Right / Up, Down
Test time : 600sec (10min)

Shock

Standard IEC60255-21-2 classⅡ

Detail contents Impulse : 30g (g : Acceleration of gravity)
Permission method : Front, Rear / Left, Right / Up, Down

1.4.4 Temperature and Humidity Test

Standard IEC 60068-2-1/2
Operating Temperature -25 ~ 70°C
Storage temperature -30~75°C
Humidity RH 30~ 95%

1.5 Use environment

Altitude	Less than 1000m
The others	Status of do not exist abnormal vibration, shock, slope and magnetic field Status of do not exist explosiveness dust, inflammable dust, inflammable/ Corrosiveness dust and salt

1.6 Protection / Detection Elements

1.6.1 Phase / Ground(Neutral) Overcurrent Protection(50/51, 50N/51N)

Pickup Current(Phase) 0.50~100.00A, 0.01 step
Pickup Current(Ground) 0.10~100.00A, 0.01 step
Definite Time 0.00~60.00sec, 0.01 step
Time Multiplier(TM) 0.01~10.00, 0.01 step
TC Curve

IEC

- Normal Inverse(IEC_NI)
- Very Inverse(IEC_VI)
- Extremely Inverse(IEC_EI)
- Long Inverse(IEC_LI)

ANSI/IEEE

- Inverse(ANSI_I)
- Short Inverse(ANSI_SI)
- Long Inverse(ANSI_LI)
- Moderately Inverse(ANSI_MI)
- Very Inverse(ANSI_VI)
- Extremely Inverse(ANSI_EI)
- Definite Inverse(ANSI_DI)

KEPCO

- Normal Inverse(KNI)
- Very Inverse(KVI)
- Definite Normal Inverse(KDNI)

1.6.2 Sensitive Directional Ground Overcurrent Protection(67Ns)

Direction Disable / Forward / Reverse
Polarizing Voltage Source -3V0 / Vg
Pickup Current(Is) 1~100mA, 1 step
Pickup Voltage 5~170V, 1 step
Operating Delay 0.00~60.00sec, 0.01 step
Maximum Torque Angle -90~+90deg, 1 step

1.6.3 Thermal Overload Protection(49)

K-Factor for IEC 60255-8 0.10~4.00, 0.01 step
Time Constant(τ) 1.0~999.9min, 0.1 step
Alarm Level 50~100% of trip temperature, 1 step

1.6.4 Undercurrent Protection(37)

Pickup Current 0.10~ 5.00A, 0.01 step
Operating Delay 0.00~180.00sec, 0.01 step

1.6.5 Negative Sequence Overcurrent Protection(46, 46T)

Pickup Current(I2)	0.50~ 100.00A, 0.01 step
Definite Time	0.00~60.00sec, 0.01 step
Time Multiplier(TM)	0.01~10.00, 0.01 step
TC Curve	Same a Phase / Ground Overcurrent Protection

1.6.6 Current Unbalance(Phase Open) Protection(46U)

Pickup Current(I2/I1)	2~80%, 1 step
Minimum Pickup of I1	0.50~5.00A, 0.01 step
Operating Delay	0.00~60.00sec, 0.01 step

1.6.7 Overvoltage(59) / Undervoltage(27) Protection

Pickup Voltage	5~170V, 1 step
Definite Time	0.00~60.00sec, 0.01 step
Time Multiplier	0.01~10.00, 0.01 step
TC Curve	Refer to Appendix A. TC Curve

1.6.8 Residual / Ground Overvoltage Protection(59G)

Source	3V0 / Vg
Pickup Voltage	5~170V, 1 step
Definite Time	0.00~60.00sec, 0.01 step
Time Multiplier	0.01~10.00, 0.01 step
TC Curve	Refer to Appendix A. TC Curve

1.6.9 Negative Sequence Overvoltage Protection(47)

Pickup Voltage(V2)	5~170V, 1 step
Operating Delay	0.00~60.00sec, 0.01 step

1.6.10 Under / Overfrequency Protection(81U/O)

Mode	Under / Over
Pickup Frequency	45.00~65.00Hz, 0.01 step
Undervoltage Block Pickup	5~170V, 1 step
dF/dT Block Pickup	-10.0~+10.0Hz/s, 0.1 step
Operating Delay	0.00~180.00sec, 0.01 step

1.6.11 Auto Reclosing(79)

Counter	1~4, 1 step
Prepare/Start/Stop Condition	Setting by EasyLogic™
Prepare Time	0.05~200.00sec, 0.01 step
Discriminating Time	0.01~5.00sec, 0.01 step
Reclaim Time	0.01~350.00sec, 0.01 step
1^{st}~4^{th} shot Delay Time	0.01~300.00sec, 0.01 step

1.6.12 Circuit Breaker Failure Protection(50BF)

Trip Relay / Binary Input	T1~T6, DI1~DI16
Pickup Current(CB Closed)	0.20~ 2.50A, 0.01 step
Operating Delay(Trip Timer)	0.00~60.00sec, 0.01 step

1.6.13 Phase Direction Detection(67)

Direction	Forward / Reverse
Maximum Torque Angle	-90~+90degree, 1 step
Direction Transition Delay Time	approx. 40msec
Minimum Voltage	3V, fixed
Minimum Current	0.05A, fixed
Memory Voltage	1sec(after all phase voltage disappeared)

1.6.14 Ground Direction Detection(67N)

Direction	Forward / Reverse
Maximum Torque Angle	-90~+90degree, 1 step
Direction Transition Delay Time	approx. 40msec
Polarizing Voltage Source	3V0 / Vg
Pickup Voltage	5~170V, 1 step
Minimum Current	0.05A, fixed

1.6.15 Cold Load Pickup(COLDLD)

Current detection level	0.10~ 5.00A, 0.01 step
Operating / Reset Delay	0~1000sec, 1 step

1.6.16 Inrush Detection(Inrush)

Minimum Current(I1f)	0.10~2.50, 0.01 step
Pickup(I2f/I1f)	10~100%, 1 step
Operating Delay	0.00~60.00sec, 0.01 step

1.6.17 Protection Elements Accuracy

Pickup	± 3% of setting value
Operating Time	±3% or ±40msec of setting value
Dropout Level	96~98% of pickup value
Dropout Time	less than 40msec
Angle Accuracy	±3º

1.7 Additional Function

1.7.1 Measurement

Current	3Phase Current RMS / Angle, 0.05~250 A ±0.5%(0.5~45A), ±1.0%(>45A)
Voltage	3Phase Voltage/Line to Line Voltage RMS / Angle, 1~450V, ±0.5%
Frequency	APhase Voltage standard, 40.00~70.00 Hz (0.002Hz)
Power Factor	Each phase / 3Phase Power Factor
Power	Each phase / 3Phase Real Power, ±1.0%(PF ±0.8~1.0) Each phase / 3Phase Reactive Power, ±1.0%(PF ±0.8~1.0) Each phase / 3Phase Apparent Power, ±1.0%
Energy/Power	3Phase Real / Reactive / Apparent Energy, ±1.0%
Sequence Current	Positive, Negetive, Zero Sequence Current RMS / Angle
Sequence Voltage	Positive, Negetive, Zero Sequence Voltage RMS / Angle
Harmonic	% about fundamental Current / Voltage, 1~31 Harmonic Each phase Current / Voltage Total Harmonic Distortion (THD)
Demand	Current, Real / Reactive / Apparent Power

1.7.2 Recording

Event Recording

Maximum recording number	1024
Resolution	1msec
Event Item	Protection status(Current / Voltage inclusion), Contact Input / Output status, Setting change, Circuit breaker control, Control Power On/Off, Recoring Data clear, Circuit breaker output number change etc.
Features	When produce protection element event quantity of electricity (Frequency, Voltage/Current RMS and Angle) together recording Even if control power is lost, data is kept

Waveform Recording

Maximum recording number	Maximum eight according to setting
Sample number per cycle	64 samples/cycle
Record Type(Block × Cycle)	2×200, 4×100, 8×50
Trigger Position	0 ~ 99% (1% step)
Trigger Condition	Setting by Logic operand
Sample Data	Current, Voltage, Protection Status(Pickup / Operation), Contact Input / Output Status
Features	COMTRADE(IEEE C37.111) File Format Even if control power is lost, data is kept

MIN/MAX Recording

Distinction cycle	100ms
Record Item	Line to Line Voltage, Voltage/Current by a phase, 3Phase Real/Reactive/ Apparent Power, 3Phase Power Factor, Demand current by a phase, 3Phase Demand Real/Reactive/Apparent Power, Frequency
Features	When produce MIN/MAX occurrence time together recording Even if control power is lost, data is kept

1.7.3 Sequence Logic(EasyLogic)

Operand	Circuit Breaker Open/Close control, Protection operation status, Self-diagnosis status, Monitoring operation status, Contact input status, Logic Operation status
Operator	AND (2~8 inputs) , OR (2~8 inputs) , NAND(2~8 inputs) , NOR(2~8 inputs) , NOT , LATCH (S,R) , Timer (On, Off, Pulse)
Features	Up to 48 operators can be used Sequence logic is composed using Operand/Operator

1.7.4 Control

Circuit Breaker

Number	2 CB
Interlocking	Through EasyLogic, freely composition possibility
Local Control	Control because use KeyPad for control Malfunction prevention by password input
Remote Control	Control through rear RS-485 communication port or contact input

Setting Group

Number	4 Setting Group
Local Control	Through KeyPad, change in Setting/System
Remote Control	Change through rear RS-485 communication port

2 Operational Description

2.1 Front Panel

Front panel of PAC-F100 is consisted of graphic LCD(240×128, 30 Character×16 Line), 16 LEDs and 11 keypad buttons and RS232C communication port.

This relay becomes to prevent malfunction by password input when operate setting value change or control keypad. Protection function is achieved in interval that operates driving information through LCD, and marks update in case of event of priority order occurs.

If connect PACManager™ on front RS232C port, setting value change, work of event/fault waveform/MIN/MAX recording transmission is available conveniently to notebook.

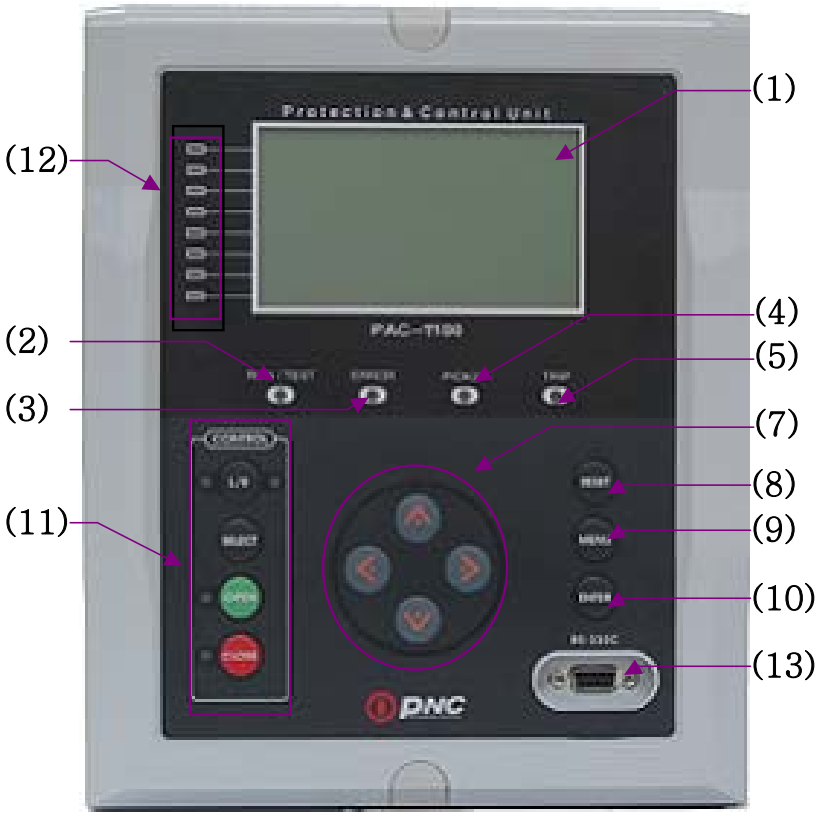


Figure 2-1 Front Panel

Table 2-1 LED/LCD Function

LED/LCD		Function
(1) LCD		Setting value, metering, driving screen display
(2) "RUN/TEST"		"GREEN", Lighting a LED when input control power , Flicker a LED when it is contact output/front display department test
(3) "ERROR"		"RED", Lighting a LED when occur system error , LED status reset through 'RESET' Key
(4) "PICKUP"		"YELLOW", Lighting a LED when is protection element pickup
(5) "TRIP"		"RED", Lighting a LED when is protection element operation , LED status reset through 'RESET' Key
(11) Control	"L/R" LED	"GREEN"(Local)/"RED"(Remote) Local/Remote control possibility status display
	"OPEN" LED	"GREEN" Lighting a LED when circuit breaker is open status
	"CLOSE"LED	"RED" Lighting a LED when circuit breaker is close status
(12) Programmable LED		"RED", eight, Through EasyLogic Editor, function set

Table 2-2 Key Function

KEY		Function
(7) Direction Key	∧	Early measure screen item change Menu move, setting value range change
	∨	
	>	Menu move, Menu item select
	<	Menu move, ESC(High position menu move, item cancel)
(8) RESET		"ERROR" LED and "TRIP" LED reset EasyLogic 'ANN_RESET' Operand' operation
(9) MENU		From early screen to Menu Tree screen move
(10) ENTER		Setting value input and Command Menu Yes/No Confirm
(11) Control	L/R	Local/Remote control position change
	SELECT	Circuit breaker choice to control
	OPEN	Choice circuit breaker open control
	CLOSE	Choice circuit breaker close control
(13) RS-232 communication port for connection of PACManager		

LCD screen of PAC-F100 is separated into early screen and menu composition screen.
Early screen shows information of various measured data, system time information, event number, fault waveform number, setting group etc. to use ∧ ∨ direction key.

2.2 Early screen

Product model, communication status, six measure display, event and waveform recording save number, single diagram, a choice circuit breaker name, system time, auto-Reclosing counter, setting group of present are registered to early screen.

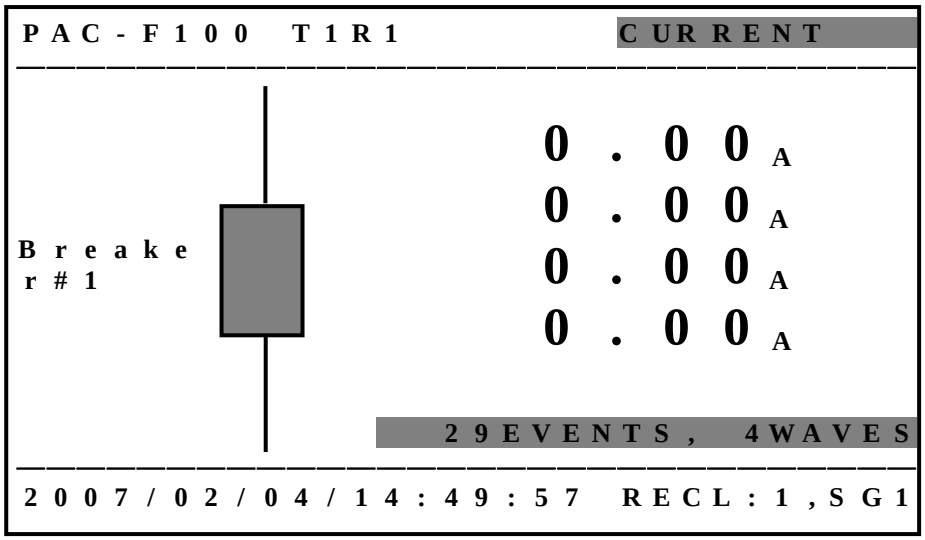


Figure 2-2 LCD Early screen

2.2.1 Measured data

Early measurement screen of PAC-F100 is consisted of total 6 and each item can confirm using Up/Down arrow keys. Composition contents of early measurement screen are same lower part.

Table 2-3 LCD Early measurement screen item

LCD display item	Description
LINE VOLT	Primary Line to line voltage(VAB, VBC, VCA)
CURRENT	Primary Phase/ground current(IA, IB, IC, IN)
A PHASE	A Phase Voltage/Current/Real power/Reactive power/Apparent power
B PHASE	B Phase Voltage/Current/Real power/Reactive power/Apparent power
C PHASE	C Phase Voltage/Current/Real power/Reactive power/Apparent power
TOTAL	3Phase Real power/Reactive power/Apparent power /Power factor/Frequency

2.2.2 Circuit breaker status display and control

Control authority of circuit breaker and present state of circuit breaker are registered by LED though circuit breaker sets function of ***SETTING/SYSTEM/BREAKER/BREAKER#1*** by EANBLED and picture of circuit breaker is expressed on LCD screen. Circuit breaker is not expressed, and must set function of ***SETTING/SYSTEM/BREAKER/BREAKER#1*** by EANBLED in case of LED of circuit breaker controlling means have turned off on LCD screen.

Circuit breaker is not expressed even if BREAKER#1's function is set by DISABLED, and BREAKER#2's function was set by EANBLED. In case of circuit breaker was set normally, status is registered by open(□) or close(■) in LCD. BREAKER#1's function is set by EANBLED and circuit breaker was expressed on LCD screen, must set circuit breaker setting again after it is rapidly if the subroutine appears as absurd(☒ or ▬) and circuit breaker status LED(open, close) flickers.

In case of circuit breaker status is registered by Error(☒), 52a input and 52b input of circuit breaker were set by all None or when function of set digital input is set by DISABLED, set according to circumstance in case of it is None because it is and must set function of relevant digital input through EasyLogic Editor of PACManagerTM by EANBLED in case digital input is set by DISABLED. Must set normally after inspect catenate status of digital input and status of circuit breaker because mean that status of circuit breaker 52a digital input and 52b digital input has same cost in case of circuit breaker status is registered by trouble(■).

In case of control authority must become local and controls circuit breaker in remote through communication in case of control circuit breaker on the spot, control authority must become remote. Press L/R key in case of control authority setting differs and must change control authority. Circuit breaker control authority change is as following. L/R key -> Control Password input -> ENTER key -> L/R key. Circuit breaker control authority change is possible in local.

When make control authority of circuit breaker by local to control circuit breaker on the spot, I press SELECT key. I press ENTER key after input control password moving particularly each position using up(∧), down(∨), left(<), right(>) key in case of ask password. If press SELECT key after input right password, picture of circuit breaker blink.
If press SELECT key better two times in case of want control of the second circuit breaker, picture of the second circuit breaker blink.
Press OPEN or CLOSE key according to user's intention and controls circuit breaker. If do control command such as present state, in case of phrase which is already present state orders LCD to appear for the lower line and differs with present state the command phrase LCD for the lower line appear and contact output that control command is established acts. When control local CB, password must be input.

Can control in high position communication or SCADA through RS485 communication after make control authority of circuit breaker through circuit breaker control authority change method by Remote status in case of want circuit breaker control in Remote.

2.2.3 The other display

Time registered under LCD for line means now system time and "EVENTS", "WAVES" displays recorded event, fault data number. "RECL" displays auto-reclosing counter, and registered in case of auto-reclosing is progressing. Setting group of protection element that "SG1" is applied present means GROUP#1.

"T1R1 (T2R2)" display of LCD first line marks transmission of RS485 communication and reception. "T1" means ‘tx data’ of COM1 and "R1" means ‘rx data’ of COM1 and "T2" means ‘tx data’ of COM2 and "R2" means ‘rx data’ of COM2.

2.2.4 Display switchover

Relay is switched over automatically by ***PROTECTION*** item of ***DISPLAY/STATUS*** menu if protection element operates in measurement screen. Relay return by early screen if automatic switchover condition is returned and key operation does not occur more than 3 minutes.

LCD returns by early screen as backlight turns off if do not handle key for 3 minutes.

2.2.5 LED Latched Status Clear

"TRIP" LED Clear

"TRIP" LED is lighted up in case of protection element more than one operates by representative LED of protection element action. "TRIP" LED Clear presses RESET key 2 times when all protection elements are reset. First, if show protection element that operate because is converted automatically by ***DISPLAY/STATUS/PROTECTION*** menu if presses RESET key and presses the second RESET key, status is initialized.

"ERROR" LED Clear

"ERROR" LED is lighted up in case of self-diagnosis element more than one operates by representative LED of self-diagnosis status display. "ERROR" LED Clear presses RESET key 2 times when all self-diagnosis elements are returned. First, if show self-diagnosis element that operate because is converted automatically by ***DISPLAY/STATUS/ SELF_DIAGNOSIS*** menu if presses RESET key and the second RESET key, status is initialized.

2.3 Menu structure display

Menu composition screen is separated into DISPLAY block that mark status, metering, record etc, and SETTING block that set or displays setting value of system and protection element and COMMAND block that can initialize record and set trip counter of circuit breaker and status of point of contact and test front panel.

Menu tree key handle

Relay is switched over in menu composition screen if press MENU key in early screen. Refer menu composition screen, can select menu wanting through up(∧), down(∨), left(<), right(>) key.

Example 1) In case of move from early screen to event screen
MENU(DISPLAY) >(STATUS) ∨(METERING) ∨(RECORD) >(EVENT)

Example 2) In case of move from event screen to RTC setting screen
<(RECORD) <(DISPLAY) ∨(SETTING) >(SYSTEM) >(PASSWORD)
∨(POWER SYSTEM) ∨(RTC)

Relay is switched over to details menu if press right(>) key in least significant menu. It is meaning that details menu is extant more than two in case of title of the first line blinks in details menu. Press right(>) key if details menu to change setting after presses up(∧), down(∨) key is published and select details menu. In the case of ***SETTING/PROTECT#*** item, protection group of present state blinks if press right(>) key, and come to low order menu if press right(>) key after choose protection group which wish to change setting pressing up(∧), down(∨) key.

Details item of menu configuration item wants to refer menu composition screen.

Table 2-4 Menu composition screen

Early screen	DISPLAY	STATUS	CONTACT INPUT	Contact input status
			CONTACT OUTPUT	Contact output status
			LED	Programmable LED status

			LOGIC COMPONENT	EasyLogic Component status
			SELF_DIAGNOSIS	Self-diagnosis status
			MONITORING	Monitoring status
			PROTECTION	Protection operation status
		METERING	POWER QUANTITY	Power quantity metering
			HARMONIC	Harmonic metering
		RECORD	EVENT	Event occur data
			WAVEFORM	Fault waveform data
			MIN/MAX	Min/Max data
		SYS INFO		MPU and DSP version
	SETTING	SYSTEM	PASSWORD	Password setting
			POWER SYSTEM	Power system and wiring setting
			RTC	System time setting
			WAVEFORM RECORD	Waveform record setting
			BREAKER	Circuit breaker status and setting
			COMMUNICATION	COM1, 2 setting
			MONITORING	Monitoring setting
			DEMAND	Demand setting
		EASY LOGIC	CONTACT INPUT	Contact input setting display
			CONTACT OUTPUT	Contact output setting display
			LED	Programmable LED setting display
			LOGIC COMPONENT	EasyLogic Component setting display
		PROTECT #1 ~ #4	OC(50/51)	Overcurrent setting
			OCG(50N/51N)	Ground overcurrent setting
			SG(67Ns)	Sensitive ground overcurrent setting
			THERMAL(49)	Thermal setting
			UC(37)	Undercurrent setting
			NSOC(46/46T)	Negative sequence overcurrent setting
			UBOC(46U)	Unbalance overcurrent setting
			OV(59)	Overvoltage setting
			UV(27)	Undervoltage setting
			OVG(59G)	Ground overvoltage setting
			NSOV(47)	Negative sequence overvoltage setting
			FREQ(81U/O)	Under/over frequency setting
			AREL(79)	Auto-reclosing setting
			CBF(50BF)	Circuit breaker fail setting
			PHS DIR(67)	Phase direction detection setting
			GND DIR(67N)	Ground direction detection setting
			COLD LD	Cold Load Pickup setting
			INRUSH	Inrush detection setting
	COMMAND	CLEAR Wh,Varh		Wh/Varh data clear
		CLEAR EVENT		Event data clear
		CLEAR WAVEFORM		Waveform data clear
		CLEAR THERMAL		THERMAL data clear
		RESET MIN/MAX		MIN/MAX data clear
		CONTACT OUT TEST		Contect output test
		PANEL TEST		Front panel LCD/LED tedt
		TRIP COUNTER SET		Circuit breaker trip counter setting
		LCD CONTRAST		LCD contrast setting

2.4 DISPLAY

This menu show digital input and contact output status, user appointment LED status, Logic Component status, self-diagnosis status, monitoring element and protection element operation status and firmware's version information in DISPLAY.

2.4.1 STATUS

This menu show operation status of digital input and contact output, user appointment LED operation status, EasyLogic component status, self-diagnosis status, operation availability of monitoring element and protection element in ***DISPLAY/STATUS***. Status information that do not appear on screen can confirm using up(), down() key. Protection element is registered element that function is set by ENABLED.

CONTACT INPUT

DISPLAY/STATUS/CONTACT INPUT can confirm present state of 16 digital inputs. Digital input that function is set by EANBLED is registered as 'OFF' in case of it is logic 0 as 'ON' in case of input is logic 1. Digital input that function is set by DISABLED is registered as 'OFF' regardless of input state.

CONTACT OUTPUT

DISPLAY/STATUS/CONTACT OUTPUT can confirm present output state of 16 contact output. Contact output that function is set by EANBLED is registered as 'ENERGIZED' in case of was displayed, and is registered as 'DEENERGIZED' in case of output was not made. Contact output that function is set by DISABLED is registered as 'DEENERGIZED'.

LED

DISPLAY/STATUS/LED can confirm output state of 8 user appointment LED. LED that function is set by EANBLED is registered as 'OFF' in case of 'ON', output was not made in case of output was made. LED output that function is set by DISABLED is registered as 'OFF'.

LOGIC COMPONENT

DISPLAY/STATUS/LOGIC COMPONENT can confirm present state of 48 logic component. Logic component that function is set by EANBLED is registered as 'OFF' in case of it is logic 0 as 'ON' in case of input is logic 1. Logic component that function is set by DISABLED is registered as 'OFF'.

SELF_DIAGNOSIS

DISPLAY/STATUS/SELF DIAGNOSIS can confirm self-diagnosis status. Relay is registered as 'OK' in case of it is particularly normally each item. Relay is registered as 'FAIL' in case of is absurd and SYSTEM ERROR LED is lighted up.
Self-diagnosis item is memory, setting range, AD converter, DC power, CPU exception, DSP, analog input circuit, easylogic setting, contact input circuit, contact output circuit.

MONITORING

DISPLAY/STATUS/MONITORING can confirm status of monitoring elements. Relay is registered as 'OK' in case of it is particularly normally each item. Relay is registered as 'FAIL' in case of is absurd.
Monitoring item is PT fuse failure, current input circuit, voltage unbalance, current unbalance, trip circuit supervision. Monitoring element that function is set by DISABLED is registered as 'OK'.

PROTECTION

Protection element set by DISABLED is not shown in ***DISPLAY/STATUS/PROTECTION*** and pickup of protection element and operation status set by EANBLED is confirmed only. Operation status is displayed by the phase when it is 3-phase protection element, relay is registered as 'A' if A-phase is operated. Relay is registered as 'OP' in case it is single-phase protection element. When there is no used protection element, phrase 'NO PROTECTION ENABLED' is registered. Relay is switched over in ***DISPLAY/STATUS/PROTECTION*** screen at pickup and operation occurrence of protection element in early measurement screen.

2.4.2 METERING

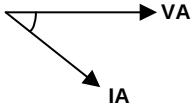
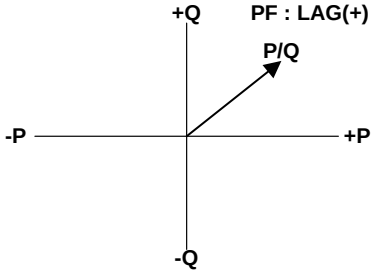
Various metering value and harmonic are confirmed in ***DISPLAY/METERING***.
DISPLAY/METERING/POWER QUANTITY can confirm various metering value. When PT connection is NONE, phase standard is A-phase current. It is A-phase voltage in case of PT connection is WYE or DELTA. Refer to below table(2.5) for details contents about metering display.
Harmonic (1 ~ 31 harmonics) and THD of voltage or current by phase is confirmed in ***DISPLAY/METERING/HARMONIC***.

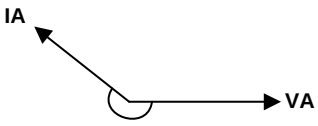
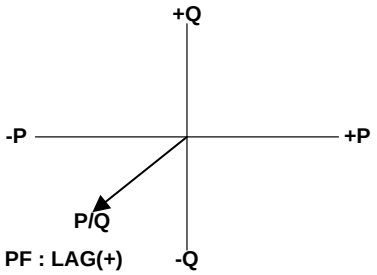
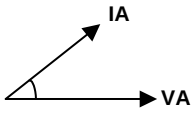
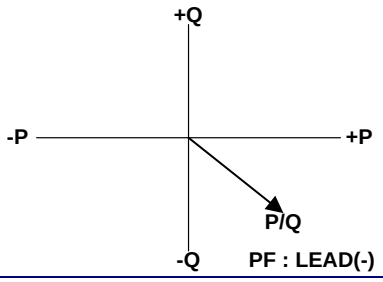
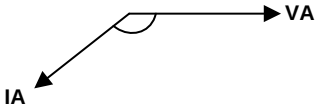
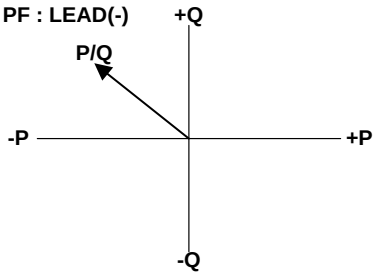
Table 2-5 Metering display

LCD Title	Item	Description
LINE VOLTAGE/CURRENT	VAB	AB Primary voltage quantity, angle
	VBC	BC Primary voltage quantity, angle
	VCA	CA Primary voltage quantity, angle
	IA	A-phase Primary current quantity, angle
	IB	B-phase Primary current quantity, angle
	IC	C-phase Primary current quantity, angle
	IN	N-phase Primary current quantity, angle
	Iavg_rms	Phase average Primary current quantity
	Is	67Ns current quantity, angle
PHASE VOLTAGE/CURRENT	VA	A-phase Primary voltage quantity, angle (reference angle)
	VB	B-phase Primary voltage quantity, angle
	VC	C-phase Primary voltage quantity, angle
	VN	N-phase Primary voltage quantity, angle
	Vavg_rms	Phase average Primary voltage quantity
	IA	A-phase Primary current quantity, angle (reference angle)
	IB	B-phase Primary current quantity, angle
	IC	C-phase Primary current quantity, angle
	IN	N-phase Primary current quantity, angle
	Iavg_rms	Phase average Primary current quantity
	Is	67Ns current quantity, angle
PHASE A POWER QUANTITY	VA	A-phase Primary voltage quantity, angle
	VAB	AB Primary voltage quantity, angle
	IA	A-phase Primary current quantity, angle
	P_A	A-phase Primary real-power quantity
	Q_A	A-phase Primary reactive-power quantity
	S_A	A-phase Primary apparent-power quantity
	PF_A	A-phase power factor (Lag : '+', Lead : '-')
PHASE B POWER QUANTITY	VB	B-phase Primary voltage quantity, angle
	VBC	BC Primary voltage quantity, angle
	IB	B-phase Primary current quantity, angle

	P_B	B-phase Primary real-power quantity
	Q_B	B-phase Primary reactive-power quantity
	S_B	B-phase Primary apparent-power quantity
	PF_B	B-phase power factor (Lag : '+', Lead : '-')
PHASE C POWER QUANTITY	VC	C-phase Primary voltage quantity, angle
	VCA	CA Primary voltage quantity, angle
	IC	C-phase Primary current quantity, angle
	P_C	C-phase Primary real-power quantity
	Q_C	C-phase Primary reactive-power quantity
	S_C	C-phase Primary apparent-power quantity
	PF_C	C-phase power factor (Lag : '+', Lead : '-')
3 PHASE POWER QUANTITY	Vavg_rms	Phase average Primary voltage quantity
	Iavg_rms	Phase average Primary current quantity
	P_3	3-phase Primary real-power quantity
	Q_3	3-phase Primary reactive-power quantity
	S_3	3-phase Primary apparent-power quantity
	PF_3	3-phase average power-factor quantity (Lag : '+', Lead : '-')
	FREQUENCY	Frequancy quantity
SEQUENCE VOLTAGE/CURRENT	V0	Primary zero sequence voltage quantity, angle
	V1	Primary positive sequence voltage quantity, angle
	V2	Primary negative sequence voltage quantity, angle
	I0	Primary zero sequence current quantity, angle
	I1	Primary positive sequence current quantity, angle
	I2	Primary negative sequence current quantity, angle
DEMAND POWER QUANTITY	DMD_IA	A-phase demand current
	DMD_IB	B-phase demand current
	DMD_IC	C-phase demand current
	DMD_P_3	3-phase demand real-power
	DMD_Q_3	3-phase demand reactive-power
	DMD_S_3	3-phase demand apparent-power
ENERGIES	kWh(IMP)	Import real-power quantity
	kWh(EXP)	Export real-power quantity
	kVarh(+)	Import reactive-power quantity
	kVarh(-)	Export reactive-power quantity
	kVAh	Apparent-power quantity
THERMAL & COUNTERS	THERMAL	Thermal quantity
	RECL_CNT	Auto-reclosing counter

Table 2-6 Power-factor display

PF	Angle	Power
LAG(+)		

		
LEAD(-)		
		

2.4.3 RECORD

Event occurrence contents and waveform save information are confirmed in ***DISPLAY /RECORD***.

DISPLAY/RECORD/EVENT show record of maximum 1024 stored in memory of PAC-F100. All fault records are recorded with information occurrence time by resolution of 1msec, and managed by FIFO mode. Fault record items have control power ON/OFF, protection element operation status, contact input/output status, circuit breaker control, setting value change, monitoring/self-diagnosis status, event data clear, waveform record clear, power quantity data clear, thermal data clear and circuit breaker counter change etc. Event is possible for setting EANBLED/DISABLED each function.

Event for operation status of protection element records fault information (frequency, voltage, current). Event record is shown through LCD and confirmed in local or remote through PACManager™.

Table 2-7 Event display

Item 1	Item 2	Description
SYSTEM RESET	-POWER ON	Power ON
	-POWER DOWN	Power Down
	-WATCHDOG	Watchdog reset
SYSTEM ERROR	-MEMORY	Memory error occur
	-SETTING	Setting error occur
	-ADCONVERTER	ADConverter error occur
	-CALIBRATION	Calibration error occur
	-DC POWER	DC Power error occur

	-CPU EXCEPT.	CPU except error occur
	-DSP	DSP error occur
	-AI CIRCUIT	AI Circuit error occur
	-EasyLogic	EasyLogic error occur
	-DI CIRCUIT	DI Circuit error occur
	-DO CIRCUIT	DO Circuit error occur
ALARM OP (ALARM RLS)	-TCS_FAIL	TCS operation(reset)
	-PT_FUSE_FAIL	PT fuse monitoring operation(reset)
	-CT_SUM_FAIL	Current input circuit monitoring operation(reset)
	-PT_BAL_FAIL	Voltage unbalance monitoring operation(reset)
	-CT_BAL_FAIL	Current unbalance monitoing operation(reset)
ANNUN.RESET	-ProtOP(LOC/REM)	Protectoin annunciator reset (Local/Remote)
	-SYSERR(LOC/REM)	System error annunciator reset (Local/Remote)
SET CHG – SYS	-PASSWORD(L/R)	PASSWORD setting change (Local/Remote)
	-POWER (L/R)	POWER SYSTEM setting change (Local/Remote)
	-RTC (L/R)	RTC setting change (Local/Remote)
	-WAVEFORM(L/R)	WAVEFORM setting change (Local/Remote)
	-BREAKER (L/R)	BREAKER setting change (Local/Remote)
	-COM (L/R)	COM setting change (Local/Remote)
	-TCS (L/R)	TCS setting change (Local/Remote)
	-PT FUSE (L/R)	PT FUSE FAILURE setting change (Local/Remote)
	-CT SUM (L/R)	CURRENT SUM setting change (Local/Remote)
	-PT BAL (L/R)	VOLTAGE BALANCE setting change (Local/Remote)
	-CT BAL (L/R)	CURRENT BALANCE setting change (Local/Remote)
	-DEMAND (L/R)	DEMAND setting change (Local/Remote)
SET CHG -LOG	-CONT IN (L/R)	CONTACT INPUT setting change (Local/Remote)
	-CONT OUT(L/R)	CONTACT OUTPUT setting change (Local/Remote)
	-LED (L/R)	LED setting change (Local/Remote)
	-L_CMP (L/R)	LOGIC COMPONENT setting change (Local/Remote)
SET CHG -SGx	-50_x (L/R)	IOCx(50_x) setting change (Local/Remote)
	-51 (L/R)	TOC(51) setting change (Local/Remote)
	-50N_x (L/R)	IOCGx(50N_x) setting change (Local/Remote)
	-51N (L/R)	TOCG(51N) setting change (Local/Remote)
	-67Ns (L/R)	SG(67Ns) setting change (Local/Remote)
	-49 (L/R)	THERMAL(49) setting change (Local/Remote)
	-37 (L/R)	UC(37) setting change (Local/Remote)
	-46_x (L/R)	NSOCx(46_x) setting change (Local/Remote)
	-46T (L/R)	TNSOC(46T) setting change (Local/Remote)
	-46U (L/R)	UBOC(46U) setting change (Local/Remote)
	-59_x (L/R)	OVx(59_x) setting change (Local/Remote)
	-27_x (L/R)	UVx(27_x) setting change (Local/Remote)
	-59G_x (L/R)	OVGx(59G_x) setting change (Local/Remote)
	-47 (L/R)	NSOV(47) setting change (Local/Remote)
	-50BF (L/R)	CBF(50BF) setting change (Local/Remote)
	-67 (L/R)	PHS DIR(67) setting change (Local/Remote)

	-67N (L/R)	GND DIR(67N) setting change (Local/Remote)
	-COLDLD (L/R)	COLD LD setting change (Local/Remote)
	-INRUSH (L/R)	INRUSH setting change (Local/Remote)
	-81U/O_x (L/R)	FREQx(81U/O_x) setting change (Local/Remote)
	-79 (L/R)	AREL(79) setting change (Local/Remote)
GRP CHG	SGx to SGy (L/R)	Set Group setting change (Local/Remote)
W/VAR CLEAR	-LOCAL/REOMTE	Power quantity clear (Local/Remote)
EVENT CLEAR	-LOCAL/REOMTE	Event data clear (Local/Remote)
WAVE CLEAR	-LOCAL/REOMTE	Waveform data clear (Local/Remote)
THERMAL CLEAR	-LOCAL/REOMTE	Thermal data clear (Local/Remote)
TripCnt x Set to	y	Breaker#x trip counter change
Breaker#x ID	-CLS CTRL(L/R)	Breaker#x close control (Local/Remote)
	-OPN CTRL(L/R)	Breaker#x open control (Local/Remote)
	-CLOSE	Breaker#x close
	-OPEN	Breaker#x open
	-TROUBLE	Breaker#x trouble
	-SET ERROR	Breaker#x setting error
L/R CHANGED	-LOCAL/REMOTE	CB control change (Local/Remote)
WAVEFORM	CAPTURED	Waveform data capture
PROT TRIP/ALARM/RLS	-49	Thermal Operation/Alarm/Reset
79 STATUS	-CB CLOSE #x	Auto-reclosing close circuit breaker
	-CB TRIP FAIL	CB open fail
	-CB CLOSE FAIL	CB close fail
	-SEQ. START	Auto-reclosing start
	-SEQ. SUCCESS	Auto-reclosing success
	-SEQ. FAILURE	Auto-reclosing fail
	-SEQ. STOP	Auto-reclosing stop
PROT PKP/OP/RLS	-50_x (A,B,C)	Instantaneous/Definite time overcurrent x Pickup/Operation/Reset
	-51 (A,B,C)	Time overcurrent Pickup/Operation/Reset
	-50_51 (A,B,C)	Overcurrent Pickup/Operation/Reset
	-50N_x	Instantaneous/Definite time ground overcurrent x Pickup/Operation/Reset
	-51N	Time ground overcurrent Pickup/Operation/Reset
	-50_51N	Ground overcurrent Pickup/Operation/Reset
	-67Ns	Sensitive ground overcurrent Pickup/Operation/Reset
	-37 (A,B,C)	Undercurrent Pickup/Operation/Reset
	-46_x	Instantaneous/Definite time negative sequence overcurrent x Pickup/Operation/Reset
	-46T	Time negative sequence overcurrent Pickup/Operation/Reset
	-46	Negative sequence overcurrent Pickup/Operation/Reset
	-46U	Current unbalance(Phase open) Pickup/Operation/Reset
	-59_x (A,B,C)	Overvoltage x Pickup/Operation/Reset
	-59 (A,B,C)	Overvoltage Pickup/Operation/Reset
	-27_x (A,B,C)	Undervoltage x Pickup/Operation/Reset
	-27 (A,B,C)	Undervoltage Pickup/Operation/Reset
	-59G_x	Ground overvoltage x Pickup/Operation/Reset

	-59G	Ground overvoltage Pickup/Operation/Reset
	-47	Negative sequence overvoltage Pickup/Operation/Reset
	-50BF	Circuit breaker fail Pickup/Operation/Reset
	-67 (A,B,C)	Phase direction detection Pickup/Operation/Reset
	-67N	Ground direction detection Pickup/Operation/Reset
	-COLDLD	Cold Load Pickup Pickup/Operation/Reset
	-INRUSH	Inrush current detection Pickup/Operation/Reset
	-81U/O_x	Under/overfrequency Pickup/Operation/Reset
CONT IN#x ID	-ON/OFF	Contact Input#x Operation/Reset
CONT OUT#x ID	-ON/OFF	Contact Output#x Operation/Reset
EVENT ID ERROR.		Event ID Error occur

DISPLAY/RECORD/WAVEFORM shows total number of recorded fault waveform, trigger time and trigger data stored in memory. Trigger source and block element, simple explanation is included in fault contents. Relay does record possibility to block of maximum eight according to waveform recording setting. Resolution is 64 samples per cycle and maximum write time per block is 4 seconds (50Hz, 2 block standards). Waveform recording have Current/voltage, contact input/output status, sample data of protection element operation status and is confirmed in local or remote through PACManager™ to upload. Waveform recording is recorded to COMTRADE file. This file can do use to fault analysis and fault reappearance through protection relay tester.

Relay can confirm size of MIN/MAX and occurrence time in ***DISPLAY/RECORD/MIN/MAX***. MIN/MAX distinction cycle is 100ms, and is stored into Primary value.
There is line to line voltage, voltage/current by phase, 3-phase real/reactive/apparent power, 3-phase power factor, demand current by phase, 3-pahse demand real/reactive/apparent power, frequency in MIN/MAX element. Relay can confirm uploading in local through PACManager™ or remote.

Table 2-8 MIN/MAX display

LCD Title	Item	Description
MIN LINE VOLTAGE	VAB	Minimum AB Primary voltage quantity
	VBC	Minimum BC Primary voltage quantity
	VCA	Minimum CA Primary voltage quantity
MIN PHASE VOLTAGE	VA	Minimum A-phase Primary voltage quantity
	VB	Minimum B-phase Primary voltage quantity
	VC	Minimum C-phase Primary voltage quantity
MIN CURRENT	IA	Minimum A-phase Primary current quantity
	IB	Minimum B-phase Primary current quantity
	IC	Minimum C-phase Primary current quantity
MIN POWER QUANTITY	P	Minimum 3-phase real power Primary quantity
	Q	Minimum 3-phase reactive power Primary quantity
	S	Minimum 3-phase apparent power Primary quantity
	PF	Minimum 3-phase power factor quantity (Lag : '+', Lead : '-')
MIN DEMAND CURRENT	DMD_IA	Minimum Demand A-phase Primary current quantity
	DMD_IB	Minimum Demand B-phase Primary current quantity
	DMD_IC	Minimum Demand C-phase Primary current quantity

MIN DEMAND POWER QUANTITY	DMD_P	Minimum 3-phase Demand real power Primary quantity
	DMD_Q	Minimum 3-phase Demand reactive power Primary quantity
	DMD_S	Minimum 3-phase Demand apparent power Primary quantity
MIN FREQUENCY	F	Minimum frequency
MAX LINE VOLTAGE	VAB	Maximum AB Primary voltage quantity
	VBC	Maximum BC Primary voltage quantity
	VCA	Maximum CA Primary voltage quantity
MAX PHASE VOLTAGE	VA	Maximum A-phase Primary voltage quantity
	VB	Maximum B-phase Primary voltage quantity
	VC	Maximum C-phase Primary voltage quantity
MAX CURRENT	IA	Maximum A-phase Primary current quantity
	IB	Maximum B-phase Primary current quantity
	IC	Maximum C-phase Primary current quantity
MAX POWER QUANTITY	P	Maximum 3-phase real power Primary quantity
	Q	Maximum 3-phase reactive power Primary quantity
	S	Maximum 3-phase apparent power Primary quantity
	PF	Maximum 3-phase power factor quantity (Lag : '+', Lead : '-')
MAX DEMAND CURRENT	DMD_IA	Maximum Demand A-phase Primary current quantity
	DMD_IB	Maximum Demand B-phase Primary current quantity
	DMD_IC	Maximum Demand C-phase Primary current quantity
MAX DEMAND POWER QUANTITY	DMD_P	Maximum 3-phase Demand real power Primary quantity
	DMD_Q	Maximum 3-phase Demand reactive power Primary quantity
	DMD_S	Maximum 3-phase Demand apparent power Primary quantity
MAX FREQUENCY	F	Maximum frequency

2.4.4 SYS INFO

DISPLAY/SYS INFO shows version information of MPU and DSP.

2.5 COMMAND

This menu has several command as follows, power energy delete, event delete, waveform record delete, thermal data clear, MIN/MAX data clear, contact output test, front panel test, circuit breaker counter setting and LCD contrast setting.

2.5.1 CLEAR Wh,Varh

It is menu that erases electric energy data stored to relay. If run Clear Wh or Clear Varh, all of the stored electric energy data are initialized.

Electric energy clear

(1) Press right(>) key after find CLEAR Wh,Varh in COMMAND menu.

(2) Press ENTER key after input SET password using up(^), down(v) key moving by each position using left(<), right(>) key in case of ask password in last line of screen.

(3) After input right password, contents to erase if press right(>) key are published and phrase 'NO' blinks. This time, come out menu pressing left(<) key in case of does not want delete, or presses ENTER key in phrase 'NO'.

(4) Press ENTER key if phrase 'YES' is expressed after use up(▲), down(▼) key.
Relay is converted in COMMAND screen after phrase 'ALL CLEARED' is expressed for screen last line.

2.5.2 CLEAR EVENT

This menu is cleared event data stored to relay. If run Clear Event, all of the stored event data are initialized.

Event clear

(1) Press right(▶) key after find CLEAR Event in COMMAND menu.
(2) Press ENTER key after input SET password using up(▲), down(▼) key moving by each position using left(◀), right(▶) key in case of ask password in last line of screen.
(3) After input right password, contents to erase if press right(▶) key are published and phrase 'NO' blinks. This time, come out menu pressing left(◀) key in case of does not want delete, or presses ENTER key in phrase 'NO'.
(4) Press ENTER key if phrase 'YES' is expressed after use up(▲), down(▼) key.
Relay is converted in COMMAND screen after phrase 'ALL CLEARED' is expressed for screen last line.

2.5.3 CLEAR WAVEFORM

This menu is cleared waveform data stored to relay. If run Clear Waveform, all of the stored waveform data are initialized.

Waveform clear

(1) Press right(▶) key after find CLEAR Waveform in COMMAND menu.
(2) Press ENTER key after input SET password using up(▲), down(▼) key moving by each position using left(◀), right(▶) key in case of ask password in last line of screen.
(3) After input right password, contents to erase if press right(▶) key are published and phrase 'NO' blinks. This time, come out menu pressing left(◀) key in case of does not want delete, or presses ENTER key in phrase 'NO'.
(4) Press ENTER key if phrase 'YES' is expressed after use up(▲), down(▼) key.
Relay is converted in COMMAND screen after phrase 'ALL CLEARED' is expressed for screen last line.

2.5.4 CLEAR THERMAL

This menu is cleared thermal data stored to relay. If run Clear THERMAL, all of the stored thermal data are initialized.

Clear thermal

(1) Press right(▶) key after find CLEAR THERMAL in COMMAND menu.
(2) Press ENTER key after input SET password using up(▲), down(▼) key moving by each position using left(◀), right(▶) key in case of ask password in last line of screen.
(3) After input right password, contents to erase if press right(▶) key are published and phrase 'NO' blinks. This time, come out menu pressing left(◀) key in case of does not want delete, or presses ENTER key in phrase 'NO'.
(4) Press ENTER key if phrase 'YES' is expressed after use up(▲), down(▼) key.
Relay is converted in COMMAND screen after phrase 'ALL CLEARED' is expressed for screen last line.

2.5.5 RESET MIN/MAX

This menu is cleared min/max record data stored to relay. If run RESET MIN/MAX, all of the

stored min/max record data are initialized. If run RESET MIN/MAX, all of the stored min/max record data are initialized. And quantity of electricity is recorded to each MIN/MAX in time that achieves command.

Reset MIN/MAX

(1) Press right(>) key after find RESET MIN/MAX in COMMAND menu.
(2) Press ENTER key after input SET password using up(∧), down(∨) key moving by each position using left(<), right(>) key in case of ask password in last line of screen.
(3) After input right password, contents to 'RESET MIN/MAX?' if press right(>) key are published and phrase 'NO' blinks. This time, come out menu pressing left(<) key in case of does not want delete, or presses ENTER key in phrase 'NO'.
(4) Press ENTER key if phrase 'YES' is expressed after use up(∧), down(∨) key.
Relay is converted in COMMAND screen after phrase 'ALL RESET' is expressed for screen last line.

2.5.6 CONTACT OUT TEST

This menu is to test 16 output points of contacts. If convert in test screen, done output contact turns into Enegized by all De-enegizeds. If test is preceded, LED "RUN/TEST" blinks.

Contact out test

(1) Press right(>) key after find CONTACT OUT TEST in COMMAND menu.
(2) Press right(>) key after output point of contact to test uses and selects up(∧), down(∨) key.
(3) Press ENTER key after input SET password using up(∧), down(∨) key moving by each position using left(<), right(>) key in case of ask password in last line of screen.
(4) After input right password, contents to 'RESET MIN/MAX?' if press right(>) key are published and phrase 'NO' blinks. After input right password, phrase of contact output that is expressed by 'DEENERGIZED' if press right key blinks.
(5) Status of point of contact toggles by 'ENERGIZED' and 'DEENERGIZED' whenever press up(∧), down(∨) key. And sound that RELAY sticks or drops sounds. LED "RUN/TEST" blinks during test.
(6) Relay escapes in test of contact output that select if press left(<) key.
Repeat (2)~(6) in case of want test of other contact output. When test again, password does not ask. Relay escapes in test display if press left(<) key in case of do not want test for contact output more.

2.5.7 PANEL TEST

This menu is to test 16 LEDs and LCD in front panel. All LEDs are turned on during 1 second if do front panel test and 'PAC-F100' character is expressed to LCD. And, these tests are repeated 3 times.

Panel test

(1) Press right(>) key after find PANEL TEST in COMMAND menu.
(2) Press ENTER key after input SET password using up(∧), down(∨) key moving by each position using left(<), right(>) key in case of ask password in last line of screen.
(3) After input right password, test is executed if press right(>) key.
Relay is converted in COMMAND menu screen after test is executed 3 times.

2.5.8 TRIP COUNTER SET

This menu is to change trip counter of two circuit breakers. When change relay singleness, circuit breaker trip counter before relay replace must be set for circuit breaker supervision.

TRIP COUNTER SET change

(1) Press right(>) key after find TRIP COUNTER SET in COMMAND menu.
(2) Circuit breaker that want change in circuit breaker trip counter setting display presses up(∧), down(∨) key and selects. Press right(>) key after select circuit breaker.
(3) Press ENTER key after input SET password using up(∧), down(∨) key moving by each position using left(<), right(>) key in case of ask password in last line of screen.
(4) After input right password, trip counter digit blinks if press right(>) key. Relay stores automatically if press ENTER key after make into value to set pressing up(∧), down(∨) key. Relay escapes in trip counter setting display if press left(<) key after setting ends.

2.5.9 LCD CONTRAST

It is menu to control LCD screen brightness. There is the possibility of difference for brightness of screen according to position or ambient temperature installed relay. User can control screen brightness according to environment of placed relay.

LCD CONTRAST setting

(1) Press right(>) key after find LCD CONTRAST in COMMAND menu.
(2) Press right(>) key in LCD CONTRAST change display.
(3) Press ENTER key after input SET password using up(∧), down(∨) key moving by each position using left(<), right(>) key in case of ask password in last line of screen.
(4) After input right password, LCD CONTRAST ratio blinks if press right(>) key.
(5) Press ENTER key after press up(∧), down(∨) key and finds wanted screen brightness. Because brightness ratio changes between 80.0 ~ 99.9%, when change from 99.9% to 80%, observe because can change as suddenly display is white. If is pressing up(∧), down(∨) key continuously, LCD screen brightness changes continuously. Relay escapes LCD CONTRAST screen if press left(<) key after setting ends.

3 Function

3.1 General

SETTING menu is to display or change setting value that need in function achievement of

relay. The present setting value can be confirmed by front key handling. But in case of change setting value Input password should be confirmed.

Setting by front panel

(1) Press right(>) key after select change item to use up(∧), down(∨) key in details menu to change setting value.

(2) Press ENTER key after input SET password using up(∧), down(∨) key moving by each position using left(<), right(>) key in case of ask password in last line of screen. (Password initial value is '0000')

(3) After input right password, setting value blinks if press right(>) key. In case of inputted wrong password, relay asks password again.

(4) Press ENTER key after select value that wish to set pressing up(∧), down(∨) key.

(5) If press left key before press ENTER key, relay returns by setting value ago.

(6) In case of return by early screen using left(<) key, relay asks setting save availability. This time, relay is stored by changed setting value if press up(∧), down(∨) key and press ENTER key after selects 'YES'.

(7) In case of selected 'NO', set value is canceled. In case of change several items at the same time, password does not require several times if do not escape ***SYSTEM*** or ***PROTECT*** block.

If use PACManager™, setting is possible conveniently.

3.1.1 SYSTEM

System setting items have password, power system, RTC, waveform recording, circuit breaker, communication, monitoring element and demand.

3.1.2 PASSWORD

Password used in relay is ***SET PASS*** and ***CTRL PASS***. ***SET PASS*** is used when change setting value. ***CTRL PASS*** is used when control circuit breaker by keypad. Two passwords are four figures consisted of 0 ~ 9, and initial value at product shipping is all '0000'.

If forget it after change password, setting value is not changed or control by key handling.

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3.1.3 POWER SYSTEM

There is POWER SYSTEM for analog circuit composition setting in ***SETTING/SYSTEM/POWER SYSTEM***. Setting group applied present according to SET GROUP's setting in POWER SYSTEM is decided.

Rated frequency

Rated frequency should sets equally with frequency of power system because it is important element that is used in metering of relay and protection arithmetic. When power system frequency differs with set frequency, measured data is shaken extremely or causes error in operaing characteristic of protection element. Rated frequency is set through keypad or PACManger™. Should do control power of relay OFF-ON in case rated frequency setting is changed.

PT wiring

PT wiring should sets equally with power system because it is important element that is used in metering of relay and protection arithmetic. In case of set wiring and wiring of power system differ, measured data is expressed to differ and causes malfunction of protection element. In

case of PT wiring is 'NONE', volt-meter is registered as '0V'. PT wiring can set using keypad or PACManager™.

PT Ratio

PAC-F100 has 4 voltage inputs. These are all source of protection elements that use voltage. Phase/ground voltage ratio is set to use keypad or PACManager™.

Phase/line to line voltage value = ***(PHS PT PRI/ PHS PT SEC)****input voltage (V)
Ground voltage value = ***(GND PT PRI/ GND PT SEC)****input voltage (V)

CT Ratio

PAC-F100 has 4 current inputs. These are all source of protection elements that use current. Phase/ground current ratio setting can set using keypad or PACManager™.

Phase current value = ***PHS CT RATIO****input current (A)
Ground current value = ***GND CT RATIO****input current (A)

Protection element setting group

PAC-F100 has 4 different groups about protection element. Setting group is set to use ***SETTING/ SYSTEM/ POWER SYSTEM/ POWER/SYSTEM*** menu or PACManager™ or remote communication.

SETTING/ SYSTEM/ POWER SYSTEM/ POWER SYSTEM

Setting item	Range(Step)	Unit	Description
1. FREQUENCY	60Hz, 50Hz		Rated frequency
2. PT CONNECT	NONE/WYE/DELTA		PT wiring
3. PHS PT PRI	0.01 ~ 600.00 (0.01)	kV	Phase PT Primary
4. PHS PT SEC	50.0 ~ 250.0 (0.1)	V	Phase PT Secondary
5. GND PT PRI	0.01 ~ 600.00 (0.01)	kV	Ground PT Primary
6. GND PT SEC	50.0 ~ 250.0 (0.1)	V	Ground PT Secondary
7. PHS CT RATIO	5 ~ 50000 : 5		Phase CT Ratio
8. GND CT RATIO	5 ~ 50000 : 5		Ground CT Ratio
9. SET GROUP	GROUP#1 ~ GROUP#4		Protection group setting

3.2 Protection function

Protection element setting of relay is attained through ***SETTING/PROTECT#x***.
Protection element is phase/ground overcurrent protection (50/51, 50N/51N), sensitive overcurrent protection (67Ns), thermal protection (49), undercurrent protection (37), negative sequence overcurrent protection (46, 46T), unbalance current protection (46U), overvoltage protection (59), undervoltage protection (27), ground overvoltage protection (59G), negative sequence overvoltage protection (47), under/overfrequency protection (81U/O), auto-reclosing (79), circuit breaker fail protection (50BF), phase direction detection (67), ground direction detection (67N), cold load pickup, inrush detection.

FUNCTION, BLOCK, EVENT

All protection elements have setting item, FUNCTION, BLOCK and EVENT commonly. This setting item can run protection function in particular condition if connect with EasyLogic. When FUNCTION is enabled and input of BLOCK setting is logic'1', function of protection

element is suspended. Protection function does not act if FUNCTION is disabled and event is not recorded. If EVENT is disabled even if FUNCTION is enabled, event is not recorded.

3.2.1 Phase/Ground Overcurrent Protection(50/51, 50N/51N)

Phase/Ground overcurrent protection is consisted of instantaneous/definite time phase overcurrent(50_1, 50_2), inverse time phase overcurrent(51), instantaneous/definite time ground overcurrent(50N_1, 50N_2), inverse time ground overcurrent (51N). Can embody 3 steps protection property if mix independent 3 elements by phase/ground element. Minimum operating time of instantaneous/definite time element is below 40msec. Inverse time element property curve is consisted of IEC class 4, IEEE/ANSI class 7, and KEPCO class 3.
Detection current of phase/ground overcurrent protection uses the second current that is inputted to relay.

Input current of ground overcurrent protection element can get from ground protection CT or residual connection of 3phase CT.

Detailed contents for property curve refer to Appendix A. Time characteristics Curve.

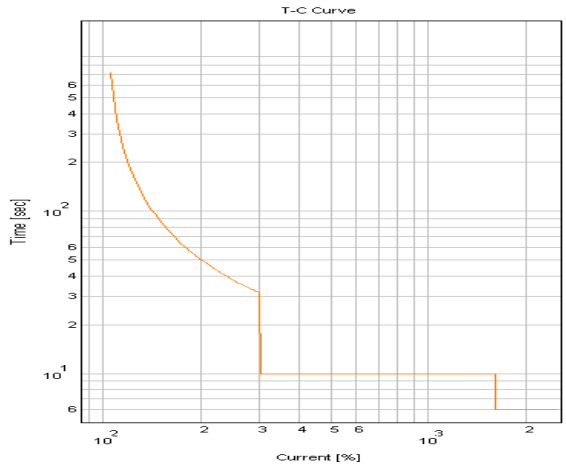


Figure 3-1 Phase/Ground overcurrent protection operating characteristic

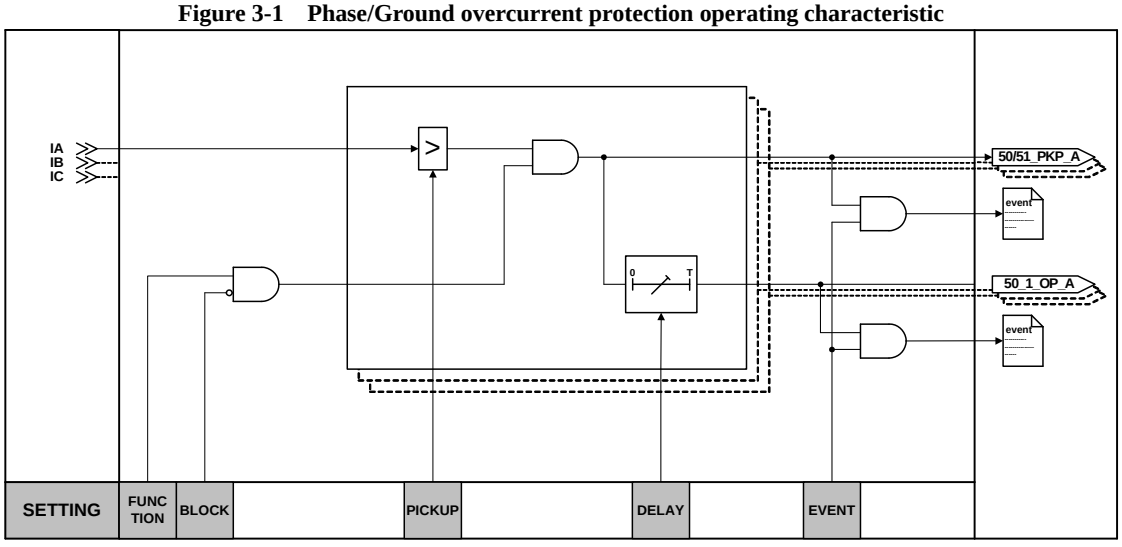


Figure 3-2 Instantaneous/definite time phase overcurrent protection operating characteristic

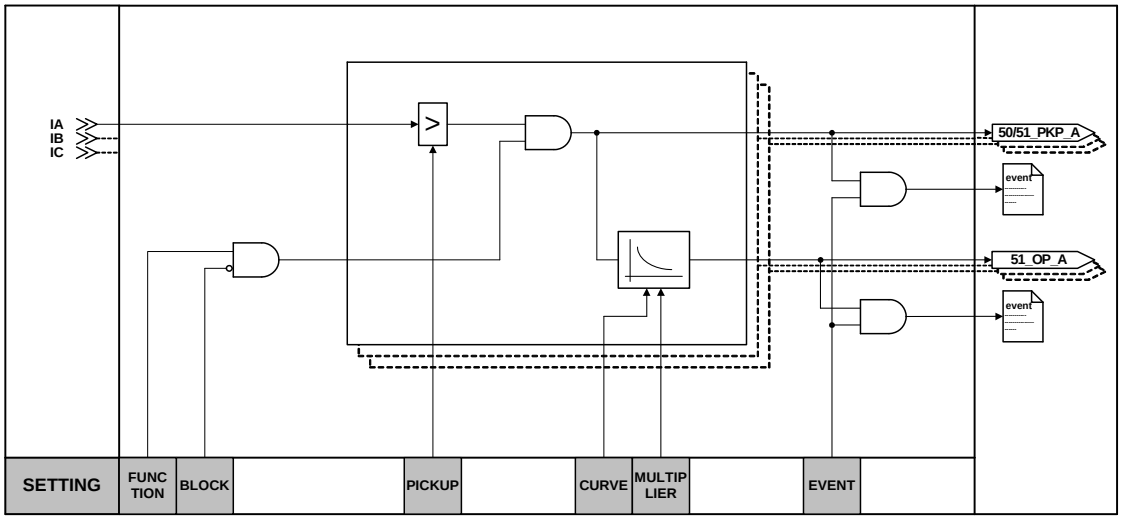


Figure 3-3 Time delay phase overcurrent protection operating characteristic

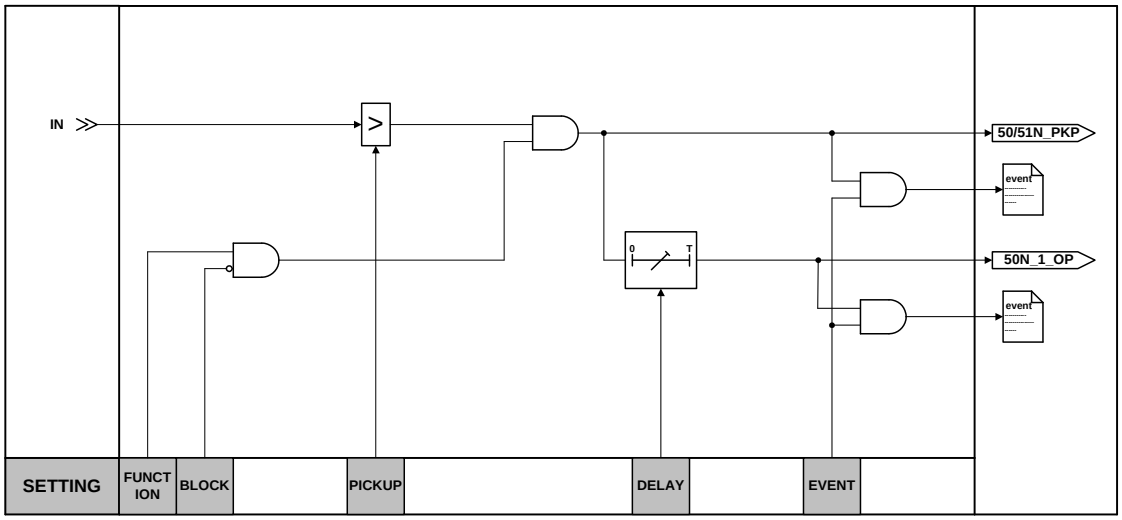


Figure 3-4 Instantaneous/definite time ground overcurrent protection operating characteristic

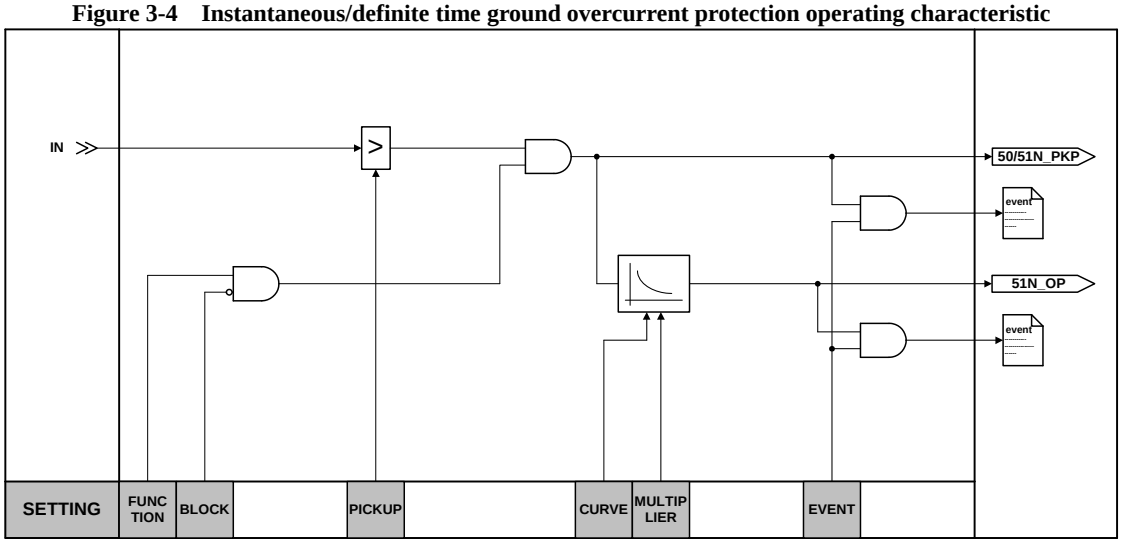


Figure 3-5 Time delay ground overcurrent protection operating characteristic

SETTING/ PROTECT#1~#4/ OC(50/51)/ IOC1(50_1), IOC2(50_2)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	0.50 ~ 100.00 (0.01)	A	Pickup current
3. DELAY	0.00 ~ 60.00	sec	Operating delay time
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

SETTING/ PROTECT#1~#4/ OC(50/51)/ TOC(51)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. CURVE	IEC_NI, …, KDNI		Inverse curve setting. IEC_NI : IEC Normal Inverse IEC_VI : IEC Very Inverse IEC_EI : IEC Extremely Inverse IEC_LI : IEC Long Inverse ANSI_I : ANSI Inverse ANSI_SI: ANSI Short Inverse ANSI_LI: ANSI Long Inverse ANSI_MI: ANSI Moderately Inverse ANSI_VI: ANSI Very Inverse ANSI_EI :ANSI Extremely Inverse ANSI_DI : ANSI Definite Inverse KNI : KEPCO Normal Inverse KVI : KEPCO Very Inverse KDNI:KEPCO Definite Normal Inverse
3. PICKUP	0.50 ~ 100.00 (0.01)	A	Pickup current
4. MULTIPLIER	0.01 ~ 10.00 (0.01)		Time Multiplier
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

SETTING/ PROTECT#1~#4/ OCG(50N/51N)/ IOCG1(50N_1), IOCG2(50N_2)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	0.10 ~ 100.00 (0.01)	A	Pickup current
3. DELAY	0.00 ~ 60.00	sec	Operating delay time
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

SETTING/ PROTECT#1~#4/ OCG(50N/51N)/ TOCG(51N)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. CURVE	IEC_NI, …, KDNI		Inverse curve setting. Is equal with phase overcurrent protection element.
3. PICKUP	0.10 ~ 100.00 (0.01)	A	Pickup current
4. MULTIPLIER	0.01 ~ 10.00 (0.01)		Time Multiplier
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
IA, IB, IC	Secondary phase current magnitude, angle
IN	Secondary ground current magnitude, angle
50/51_PKP	Phase overcurrent protection Pickup OR
50/51_PKP_A, B, C	Phase overcurrent protection A, B, C Phase Pickup
50_1_OP	Instantaneous/definite time phase overcurrent protection 1 operating OR
50_1_OP_A, B, C	Instantaneous/definite time phase overcurrent protection 1 A,B,C Phase operating
50_2_OP	Instantaneous/definite time phase overcurrent protection 2 operating OR
50_2_OP_A, B, C	Instantaneous/definite time phase overcurrent protection 2 A, B, C Phase operating
51_OP	Time delay phase overcurrent protection operating OR
51_OP_A, B, C	Time delay phase overcurrent protection A, B, C Phase operating
50/51N_PKP	Ground overcurrent protection Pickup OR
50N_1_OP	Instantaneous/definite time ground overcurrent protection 1 operating
50N_2_OP	Instantaneous/definite time ground overcurrent protection 2 operating
51N_OP	Time delay ground overcurrent protection operating

3.2.2 Sensitive ground overcurrent protection(67Ns)

Sensitive ground overcurrent protection is used by grounding fault detection of insulated system. It is direction protection element acting by input voltage according to topology of voltage input and definite time by size and angle of sensitive current.

Property of direction element, relay needs especial attention on wiring direction of sensitive current and voltage.

If voltage input is '-3V0' in case of wiring is 'NONE' or 'DELTA', protection element does not act to direction because zero sequence voltage does not occur.

When direction element is 'NONE', relay acts by size of sensitive current.

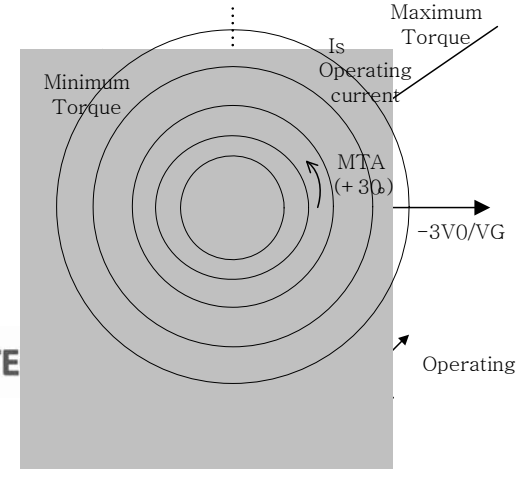


Figure 3-6 Sensitive ground overcurrent protection operating angle characteristic

Operation phase by direction of sensitive ground overcurrent protection element is as following.

FORWARD : $Co\sin e(\angle -3V0(VG)+MTA-\angle Is)\geq 0$

REVERSE : $Co\sin e(\angle -3V0(VG)+MTA-\angle Is)<0$

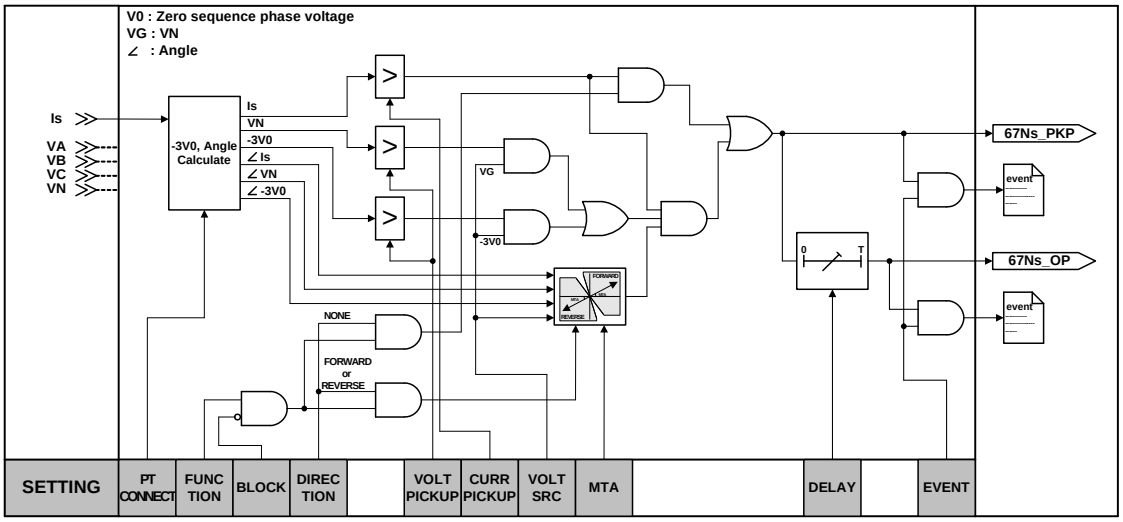


Figure 3-7 Sensitive ground overcurrent protection operating characteristic

SETTING/ PROTECT#1~#4/ SG(67Ns)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. DIRECTION	NONE,..,REVERSE		Direction setting NONE : There is no direction FORWARD REVERSE
3. VOLT SRC	-3V0/VG		Ground voltage source setting -3V0 : Zero sequence voltage VG : N Phase voltage
4. VOLT PICKUP	5 ~ 170(1)	V	Pickup voltage
5. CURR PICKUP	1 ~ 100(1)	Ma	Pickup current
6. DELAY	0.00 ~ 60.00(0.01)	sec	Operating delay time
7. MTA	-90 ~ +90	°	MTA setting
8. BLOCK	EasyLogic operand		Protection blocking condition
9. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description

Is	Sensitive current (Is) magnitude, angle
V0	Secondary zero sequence voltage magnitude, angle
VG	Secondary N phase voltage magnitude, angle
67Ns_PKP	Sensitive ground overcurrent protection Pickup
67Ns_OP	Sensitive ground overcurrent protection operation

3.2.3 Thermal overload protection(49)

Protection element can act via maximum value among three-phase current and set alarm level. Among three-phase current, thermal by time const(τ) is accumulated in case of maximum value is bigger than rated current*K-Factor. If is small, thermal by time const(τ) decreases.
In case of thermal is bigger than alarm level 'Alarm' occur, and 'Trip' is produced in case of it is more than 100%. Thermal state can confirm in measurement, and initialize compulsorily through COMMAND menu. Detailed contents for property curve expect to refer Appendix A. Time characteristics Curve.

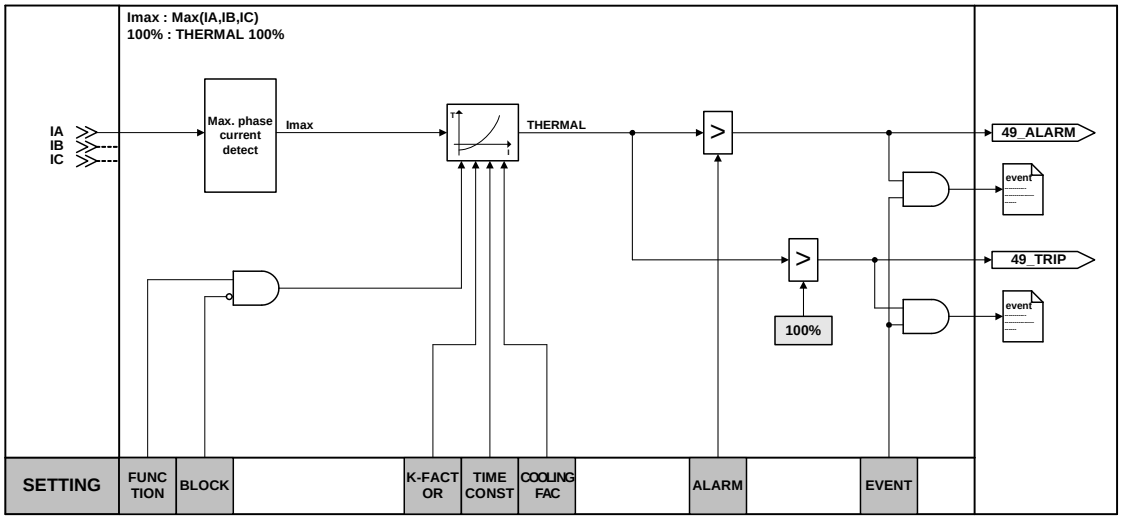


Figure 3-8 Thermal overload protection operating characteristic

SETTING/ PROTECT#1~#4/ THERMAL(49)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. K-FACTOR	0.10 ~ 4.00(0.01)		k-Factor setting
3. TIME CONST	1.0 ~ 999.9(0.1)	min	Time constant(τ) setting
4. ALARM	50 ~ 100(1)	%	Alarm level setting
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
THERMAL	Thermal %
IA, IB, IC	Secondary phase current magnitude, angle
49_ALARM	Thermal overload protection Alarm
49_TRIP	Thermal overload protection operation

3.2.4 Undercurrent Protection(37)

Undercurrent protection is usable definite time protection element by purpose of load loss, open line detection etc.

Relay operates in case of size of phase current is below Pickup.

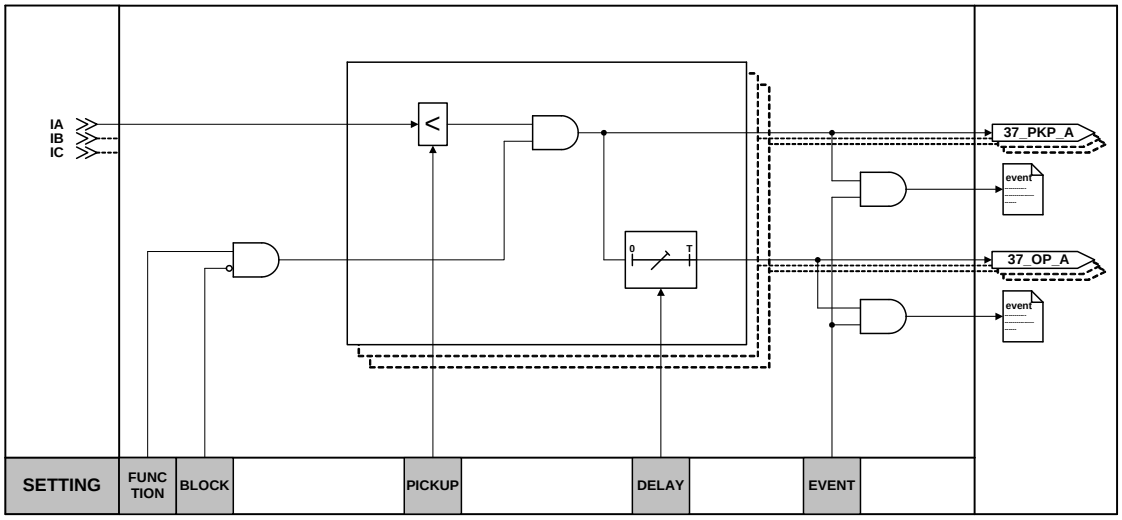


Figure 3-9 Undercurrent protection operating characteristic

SETTING/ PROTECT#1~#4/ UC(37)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	0.10 ~ 5.00 (0.01)	A	Pickup current
3. DELAY	0.00 ~ 180.00(0.01)	sec	Operation delay time
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
IA, IB, IC	Secondary phase current magnitude, angle
37_PKP	Undercurrent protection Pickup OR
37_PKP_A, B, C	Undercurrent protection A, B, C Phase Pickup
37_OP	Instantaneous/definite time undercurrent protection operation OR
37_OP_A, B, C	Instantaneous/definite time undercurrent protection A, B, C Phase operation

3.2.5 Negative Sequence Overcurrent Protection(46, 46T)

Negative sequence overcurrent protection element is applied to detect unbalance fault that ground overcurrent protection element does not detect. Negative sequence overcurrent protection element have same protection elements of instantaneous/definite time 2, inverse time 1 as phase/ground overcurrent protection (50/51, 50N/51N) element. Pickup current (I2)

of negative sequence overcurrent protection is

$I2 = \frac{1}{3}(\dot{I}_A + a^2\dot{I}_B + a\dot{I}_C)$, ABC phase rotation.

Minimum operating time of instantaneous/definite time element is below 40msec. Inverse time element property curve is consisted of IEC class 4, IEEE/ANSI class 7, and KEPCO class 3.

Detailed contents for property curve expect to refer to Appendix A. Time characteristics Curve

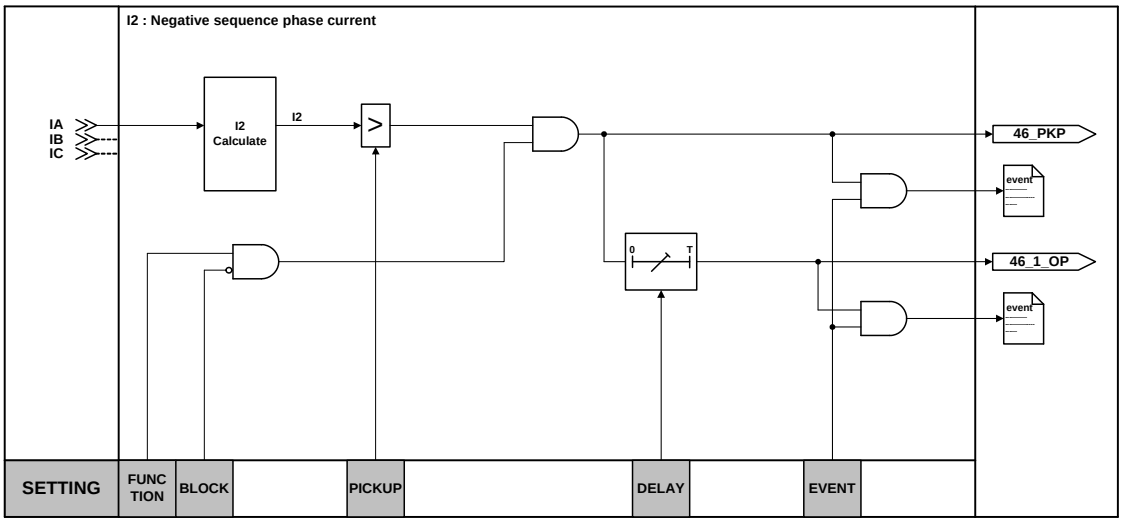


Figure 3-10 Instantaneous/definite time negative sequence overcurrent protection operating chracteristic

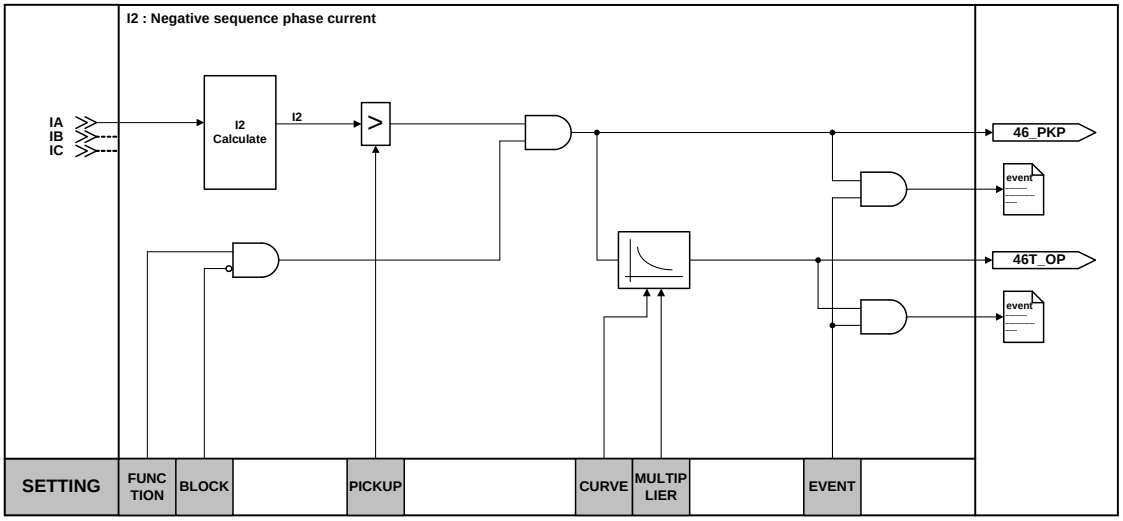


Figure 3-11 Time delay negative sequence overcurrent protection operating characteristic

SETTING/ PROTECT#1~#4/ NSOC(46/46T)/ NSOC1(46_1), NSOC2(46_2)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	0.50 ~ 100.00 (0.01)	A	Negetive sequence current Pickup

3. DELAY	0.00 ~ 60.00	sec	Operation delay time
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

SETTING/ PROTECT#1~#4/ NSOC(46/46T)/ TNSOC(46T)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. CURVE	IEC_NI, …, KDNI		Inverse curve setting. Is equal with phase overcurrent protection element.
3. PICKUP	0.50 ~ 100.00 (0.01)	A	Negetive sequence current Pickup
4. MULTIPLIER	0.01 ~ 10.00 (0.01)		Time Multiplier
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
I2	Negative sequence Secondary current magnitude, angle
46_PKP	Negative sequence overcurrent protection Pickup OR
46_1_OP	Instantaneous/definite time negative sequence overcurrent protection 1 operation
46_2_OP	Instantaneous/definite time negative sequence overcurrent protection 2 operation
46T_OP	Time delay negative sequence overcurrent protection operation

3.2.6 Unbalance current (Phase open) Protection(46U)

Unbalance current (phase open) protection can use in place that need unbalance detection of more sensitive sensitivity than negative sequence overcurrent protection element. Phase open can occur by disconnection of line, single-phase fuse loss etc. Unbalance current protection is definite time protection element that acts by ratio of negative sequence current and positive

sequence current.

Positive sequence current (I1) used in unbalance current protection is $I1 = \frac{1}{3}(\dot{I}_A + a\dot{I}_B + a^2\dot{I}_C)$, ABC phase rotation.

Positive sequence current (I2) used in unbalance current protection is $I2 = \frac{1}{3}(\dot{I}_A + a^2\dot{I}_B + a\dot{I}_C)$, ABC phase rotation.

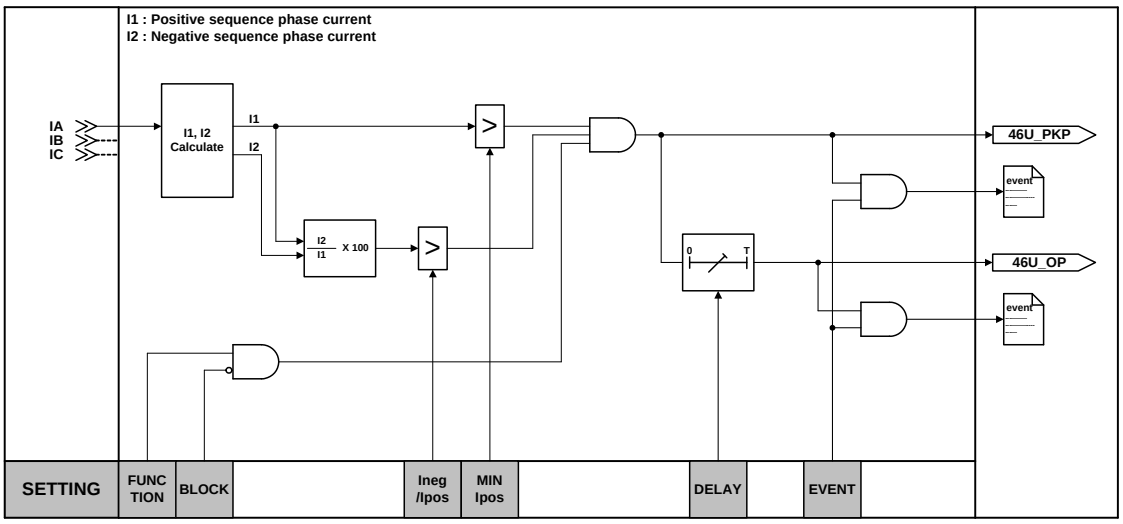


Figure 3-12 Unbalance current(phase open) protection operating characteristic

SETTING/ PROTECT#1~#4/ UBOC(46U)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. Ineg/Ipos	2 ~ 80(1)	%	Negative sequence/Positive sequence ratio setting
3. MIN Ipos	0.50 ~ 5.00 (0.01)	A	Positive sequence minimum operating current setting
4. DELAY	0.00 ~ 60.00	sec	Operation delay time
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
I1	Positive sequence Secondary current magnitude, angle
I2	Negative sequence Secondary current magnitude, angle
46U_PKP	Unbalance current(phase open) protection Pickup
46U_OP	Unbalance current(phase open) protection operation

3.2.7 Overvoltage Protection(59)/Undervoltage Protection(27)

Overvoltage protection element is 3-phase protection element that is consisted of OV1 (59_1) and OV2 (59_2) acting by definite/inverse time element that act by definite time element. Inverse time dynamic characteristic is equal with property of induction type overvoltage relay. Relay acts in case of inputted phase voltage is more than pickup. Detailed contents for

property curve expect to refer to Appendix A. Time characteristics Curve

Undervoltage protection element is 3-phase protection element that is consisted of UV1 (27_1) and UV2 (27_2) acting by definite/inverse time element that act by definite time element. Inverse time dynamic characteristic is equal with property of induction type overvoltage relay. Relay acts in case of inputted phase voltage is below than pickup. Detailed contents for property curve expect to refer to Appendix A. Time characteristics Curve.

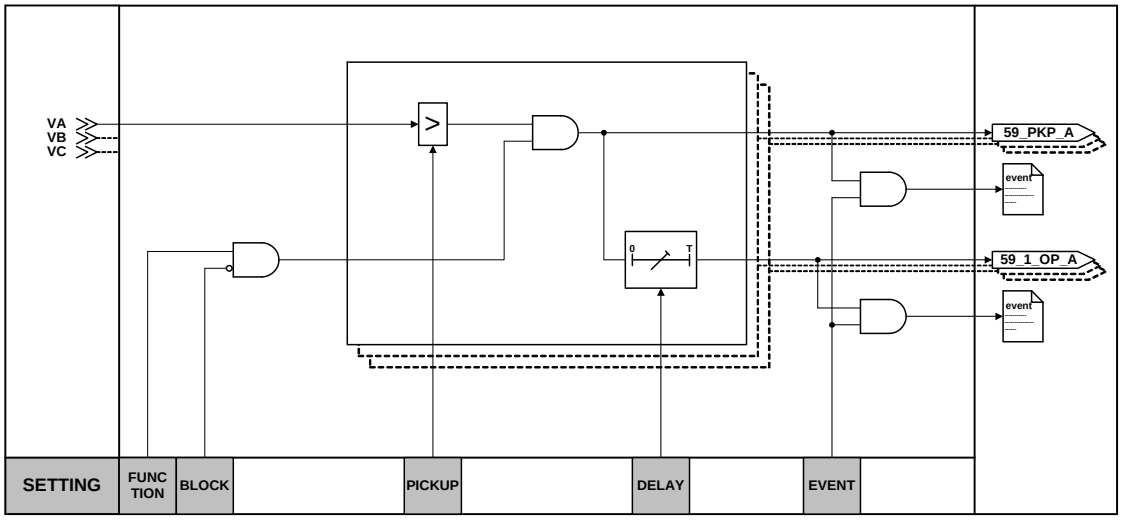


Figure 3-13 Definite time overvoltage protection operating characteristic

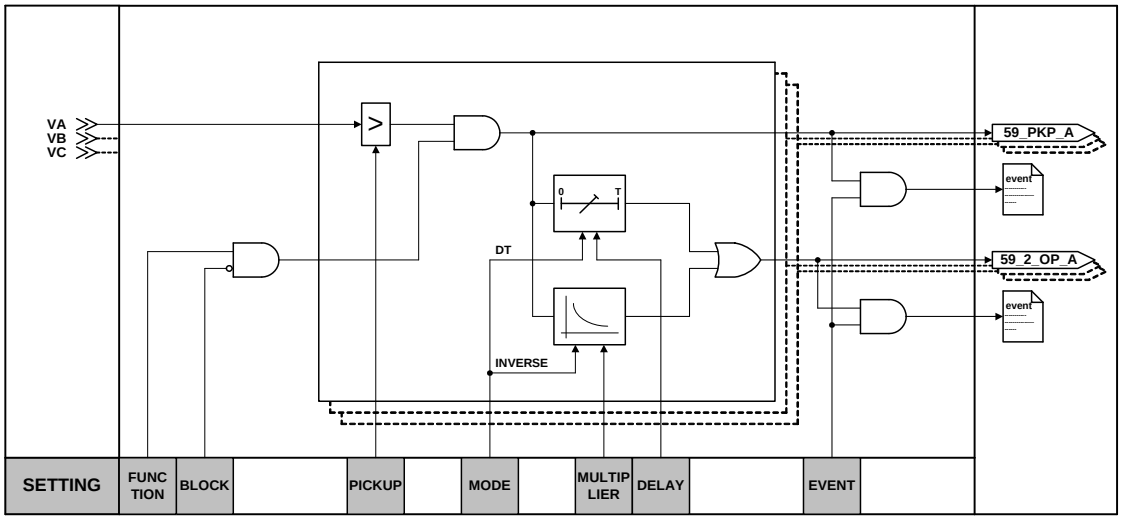


Figure 3-14 Inverse time overvoltage protection operating characteristic

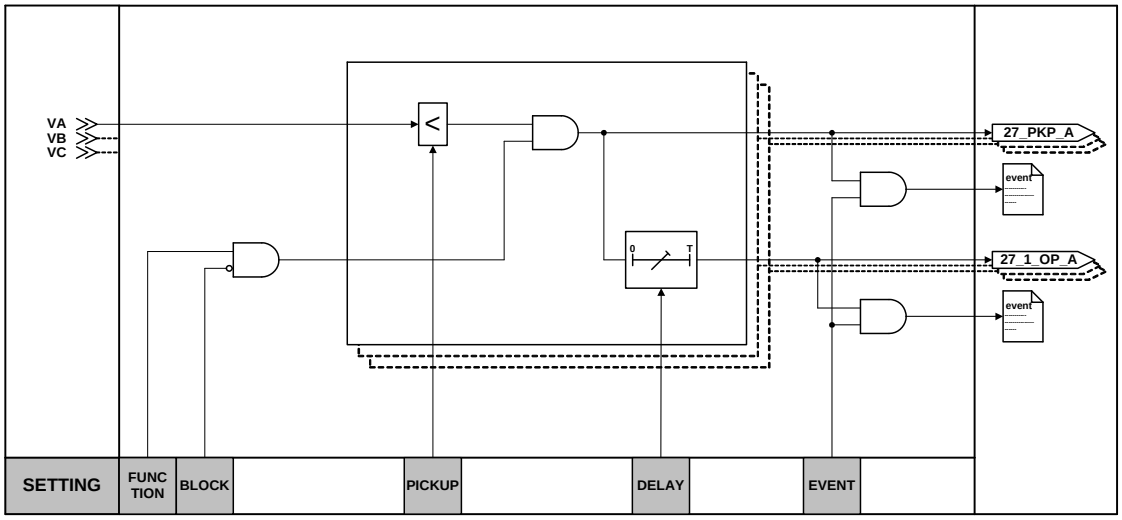


Figure 3-15 Definite time undervoltage protection operating characteristic

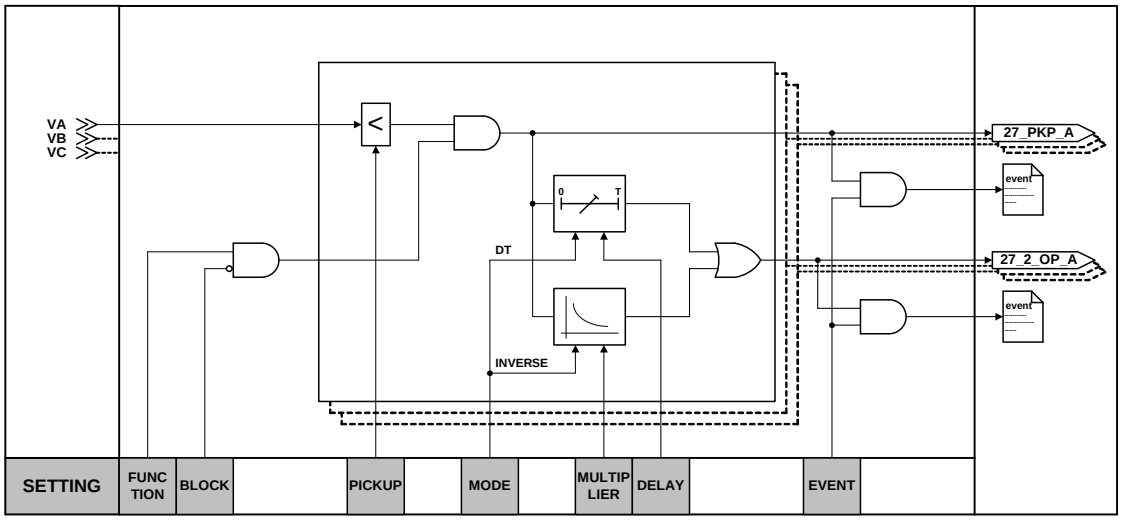


Figure 3-16 Inverse time undervoltage protection operating characteristic

SETTING/ PROTECT#1~#4/ OV(59)/ OV1(59_1)
SETTING/ PROTECT#1~#4/ UV(27)/ UV1(27_1)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	5 ~ 170 (1)	V	Voltage Pickup
3. DELAY	0.00 ~ 60.00	Sec	Operation delay time
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

SETTING/ PROTECT#1~#4/ OV(59)/ OV2(59_2)
SETTING/ PROTECT#1~#4/ UV(27)/ UV2(27_2)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. MODE	DT, INVERSE		Operating Mode setting DT : Definite time INVERSE : Inverse time
3. PICKUP	5 ~ 170 (1)	V	Voltage Pickup
4. DELAY	0.00 ~ 60.00	sec	Operation delay time
4. MULTIPLIER	0.01 ~ 10.00(0.01)		Time Multiplier
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
VA, VB, VC	Secondary phase voltage magnitude, angle
59_PKP	Overvoltage Pickup OR
59_PKP_A, B, C	Overvoltage A, B, C Phase Pickup
59_1_OP	Overvoltage 1 Operation OR
59_1_OP_A, B, C	Overvoltage 1 A, B, C Phase Operation
59_2_OP	Overvoltage 2 Operation OR
59_2_OP_A, B, C	Overvoltage 2 A, B, C Phase Operation
27_PKP	Undervoltage Pickup OR
27_PKP_A, B, C	Undervoltage A, B, C Phase Pickup
27_1_OP	Undervoltage 1 Operation OR
27_1_OP_A, B, C	Undervoltage 1 A, B, C Phase Operation
27_2_OP	Undervoltage 2 Operation OR
27_2_OP_A, B, C	Undervoltage 2 A, B, C Phase Operation

3.2.8 Ground Overvoltage Protection(59G)

Ground overvoltage protection element is 1-phase protection element that is consisted of OVG1 (59G_1) and OVG2 (59G_2) acting by definite/inverse time element that act by definite time element. Inverse time dynamic characteristic is equal with property of induction type ground overvoltage relay. Relay acts in case of inputted phase voltage is more than pickup. Zero sequence voltage can use open delta connection voltage of 3-phase PT or voltage that does arithmetic in relay inside electively. Detailed contents for property curve expect to refer to Appendix A. Time characteristics Curve

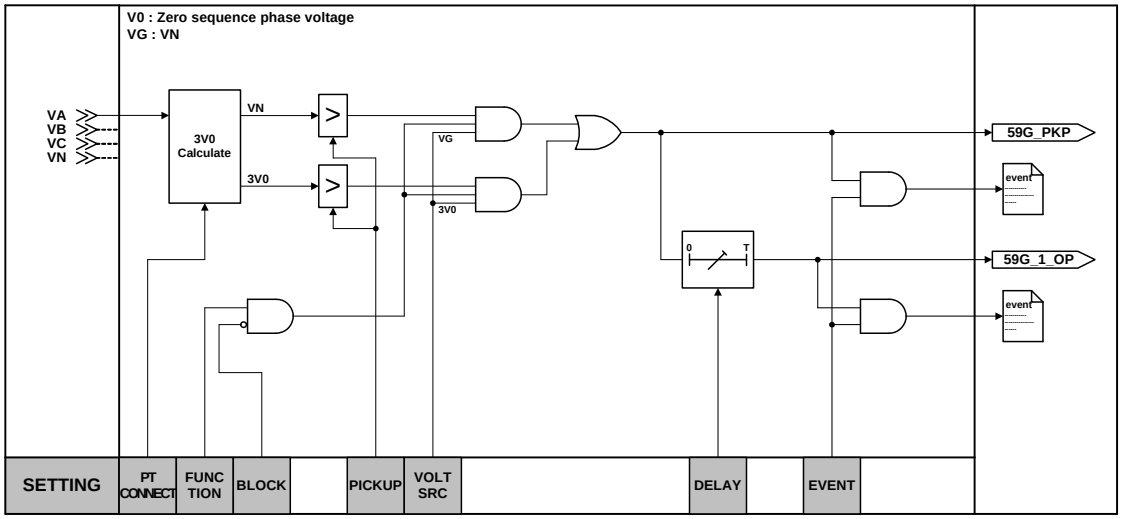


Figure 3-17 Definite time ground overvoltage protection operating characteristic

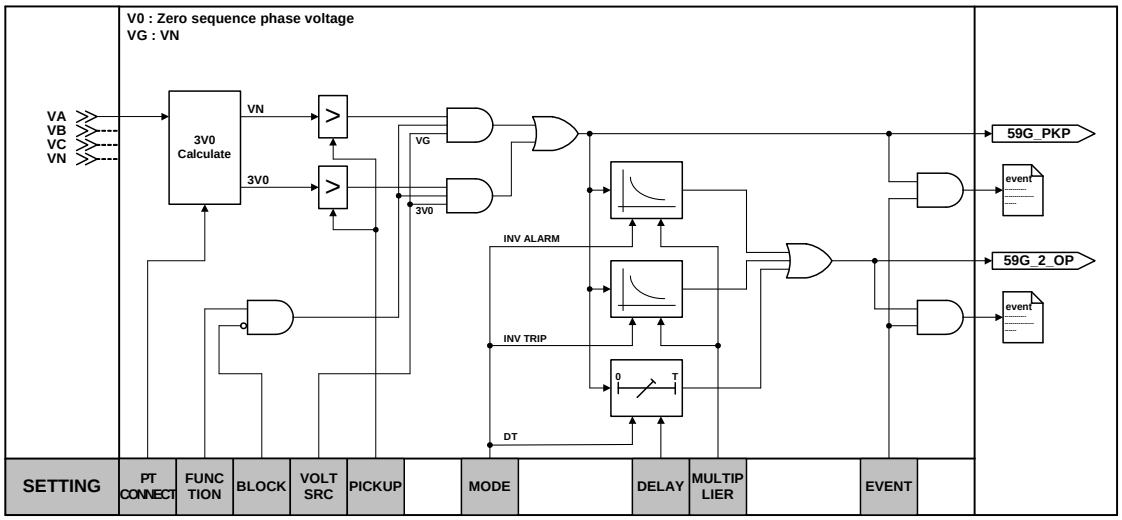


Figure 3-18 Inverse time ground overvoltage protection operating characteristic

SETTING/ PROTECT#1~#4/ OVG(59G)/ OVG1(59G_1)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. VOLT SRC	3VO, VG		Ground voltage source setting 3VO : Zero sequence voltage VG : N Phase voltage
3. PICKUP	5 ~ 170 (1)	V	Voltage Pickup
4. DELAY	0.00 ~ 60.00	sec	Operation delay time
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

SETTING/ PROTECT#1~#4/ OVG(59G)/ OVG2(59G_2)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. VOLT SRC	3V0, VG		Ground voltage source setting 3VO : Zero sequence voltage VG : N Phase voltage
3. MODE	DT,…, INV_ALARM		Operating Mode setting DT : Definite time INV_TRIP : Trip inverse time INV_ALARM : Alarm inverse time
4. PICKUP	5 ~ 170 (1)	V	Voltage Pickup
5. DELAY	0.00 ~ 60.00	sec	Operation delay time
5. MULTIPLIER	0.01 ~ 10.00(0.01)		Time Multiplier
6. BLOCK	EasyLogic operand		Protection blocking condition
7. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
VN	Secondary N Phase voltage magnitude, angle
V0	Secondary zero sequence voltage magnitude, angle
59G_PKP	Ground overvoltage Pickup OR
59G_1_OP	Ground overvoltage 1 Operation
59G_2_OP	Ground overvoltage 2 Operation

3.2.9 Negative sequence overvoltage Protection(47)

Negative sequence overvoltage protection element is definite time protection element that acts by size of negative sequence voltage.

Pickup voltage (3V2) of negative sequence overvoltage protection is $3V2 = \dot{V}_A + a^2\dot{V}_B + a\dot{V}_C$, ABC phase rotation.

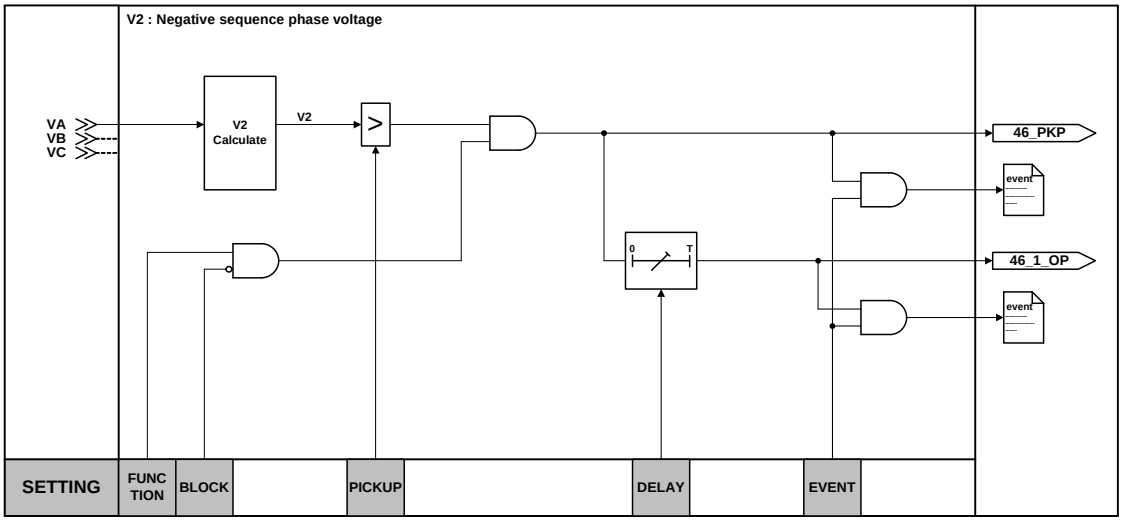


Figure 3-19 Negative sequence overvoltage protection operating characteristic

SETTING/ PROTECT#1~#4/ NSOV(47)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	5 ~ 170 (1)	V	Voltage Pickup
3. DELAY	0.00 ~ 60.00	sec	Operation delay time
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
V2	Secondary negative sequence voltage magnitude, angle
47_PKP	Negative sequence overvoltage Pickup
47_OP	Negative sequence overvoltage operation

3.2.10 Under/overfrequency Protection(81U/O)

Frequency protection element is used into expenditure that detect under/overfrequency and separates load or generator. Underfrequency demands for power increase or occurs in control failure of generator. Overfrequency occurs instantaneously when big load is detached in system. Relay offers 3 independent under/overfrequency protection elements that act by definite time.

Under/overfrequency protection element acts in case of voltage more than 10V is approved to voltage A-phase. When 'UV BLOCK', 'dF/dT BLOCK' element was activated, if undervoltage or dF/dT condition is satisfied, protection element does not act.

DF/dT means frequency fluxion per 1 cycle. Do not become blocking if dF/dT is big more than 20Hz/s.

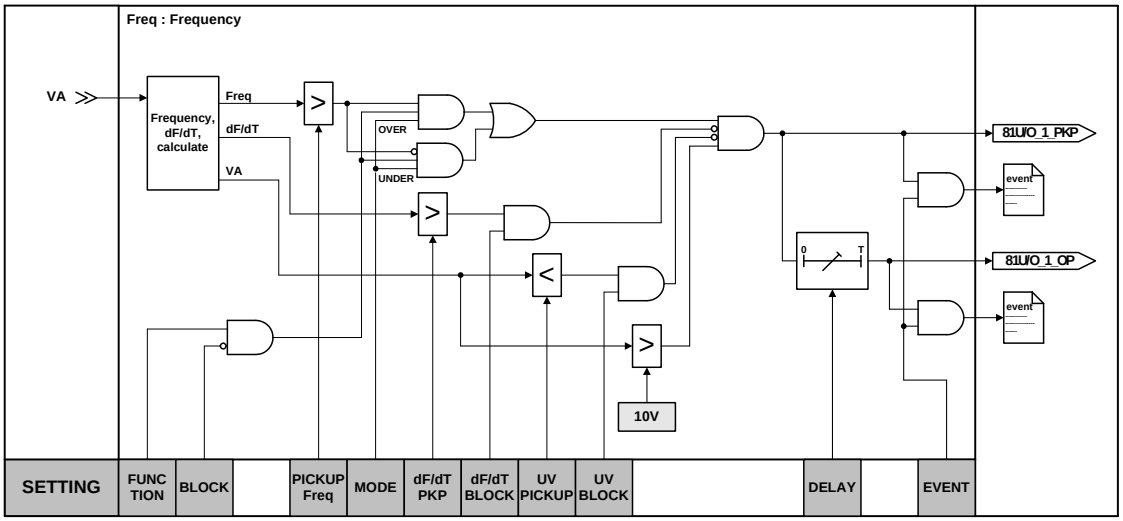


Figure 3-20 Under/overfrequency protection operating characteristic

SETTING/PROTECT#1~#4/FREQ(81U/O)/FREQ1~3(81U/O_1~3)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. MODE	UNDER, OVER		Under/overfrequency MODE select
3. Freq PICKUP	45.00 ~ 65.00(0.01)	Hz	Frequency Pickup
4. UV PICKUP	5 ~ 170(1)	V	Voltage Pickup
5. dF/dT PKP	-10.0 ~ +10.0(0.1)	Hz/s	dF/dT Pickup
6. DELAY	0.00 ~ 180.00(0.01)	sec	Operation delay time
7. UV BLOCK	NO, YES		Undervoltage Block
8. dF/dT BLOCK	NO, YES		dF/dT Block
9. BLOCK	EasyLogic operand		Protection blocking condition
10. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
FREQUENCY	Frequency magnitude
dF/dT	Frequency change/1cycle
VA	Secondary phase voltage magnitude, angle
81U/O_1_PKP	Under/overfrequency 1 Pickup
81U/O_1_OP	Under/overfrequency 1 Operation
81U/O_2_PKP	Under/overfrequency 2 Pickup
81U/O_2_OP	Under/overfrequency 2 Operation
81U/O_3_PKP	Under/overfrequency 3 Pickup
81U/O_3_OP	Under/overfrequency 3 Operation

3.2.11 Auto Reclosing(79)

Auto-reclosing element can do reclose until 4th. Preparation condition/start condition/stop condition of auto-reclosing can set variously through EasyLogic.
Function of auto-reclosing is 'ENABLED', and enters in 'Ready state' (79_READY) if preparation condition (PRE CON) is satisfied for prepare time (PRE TIME).
Relay begins recloser if start condition (START CON) is satisfied in ready state (79_READY).
Relay evades preparation condition in recloser ready state if is not satisfied before start condition is satisfied in ready state.
Enter by recloser progress state (79_IN_PROG) if begin recloser, and the first recloser delay time (1^{ST} DELAY) is begun.
Close circuit breaker after the first recloser delay time passes, and relay confirms whether relay uses circuit breaker operation discriminating time (DISC TIME) and recloser success discriminating time (RECL TIME) and circuit breaker was closed actually.
When do circuit breaker to do close, 79_FAIL occur, and does not run recloser more in recloser failure because mean that circuit breaker was not opened in recloser begin status if circuit breaker status was closed. And if circuit breaker is not closed for circuit breaker operation discriminating time, relay does not run recloser more producing 79_FAIL.
Circuit breaker is closed in circuit breaker operation discriminating time, and it is recloser success (79_SUCCESS) if more recloser start condition does not occur for recloser success discriminating time, and 2th recloser delay time (2^{ND} DELAY) is begun if recloser start condition occurs again for recloser success discriminating time.
Open circuit breaker if recloser start condition occurs after recloser counter ends, and 79_FAIL occurs and does not run recloser more.
Recloser is progressing or relay does not progress recloser more if recloser stop condition (STOP CON) is produced. And recloser success or failure status information is become Reset when become recloser ready state.
Circuit breaker injection of auto-reclosing must set circuit breaker control signal through EasyLogic of PACManager™ because is attained by CB1_CLS_CTRL.
Example about success and failure of auto-reclosing is as following.
If auto-reclosing is begun, counter of auto-reclosing can confirm through lower column department 'RECL' of early screen.

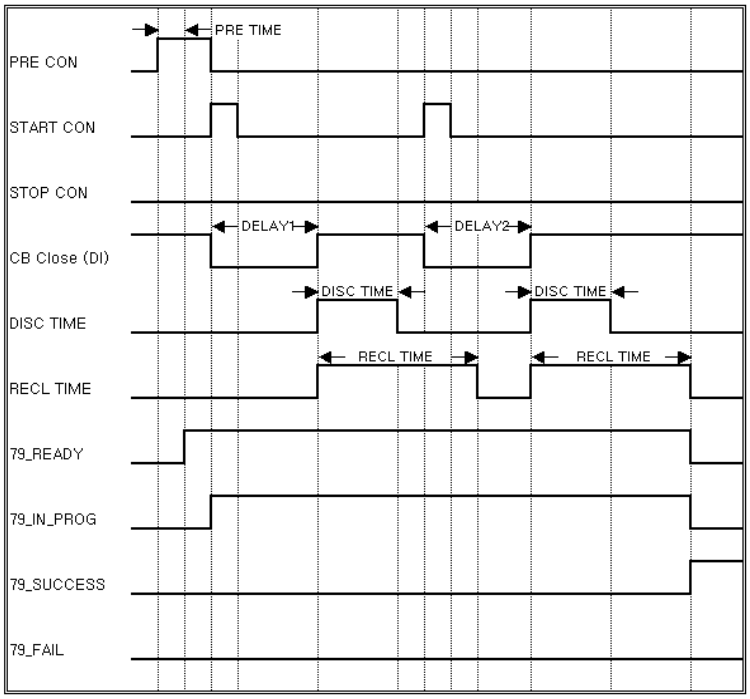


Figure 3-21 Auto-reclosing 2th recloser success

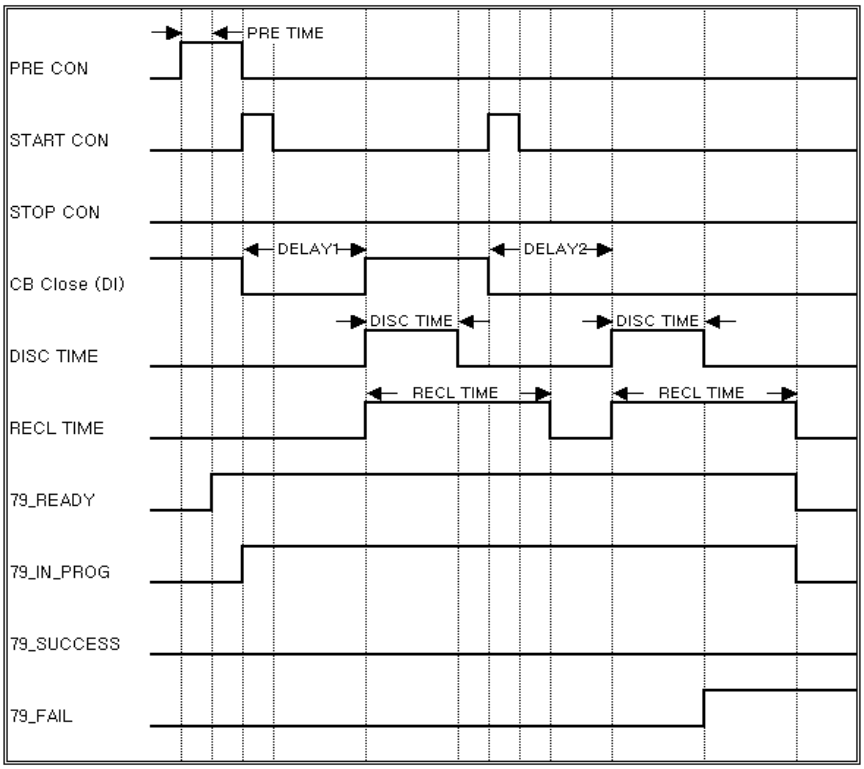


Figure 3-22 Auto-reclosing 2th recloser circuit breaker close fail

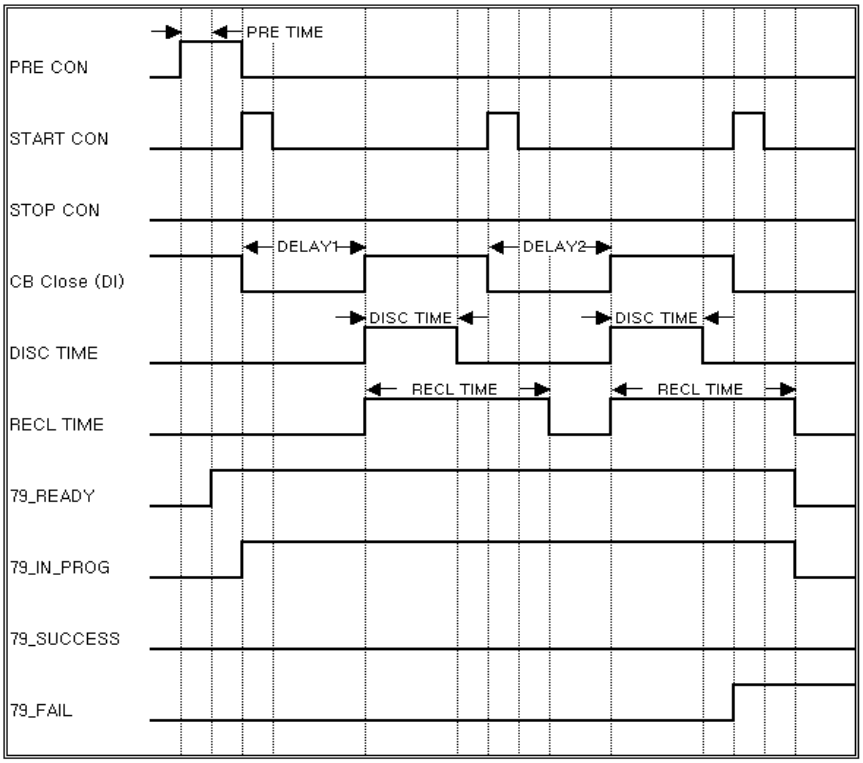


Figure 3-23 Auto-reclosing 2th recloser fail

SETTING/PROTECT#1~#4/AREL(79)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. SHOT NUM	1 ~ 4(1)		Reclosing count setting
3. PRE CON	EasyLogic operand		Reclosing prepare condition setting
4. START CON	EasyLogic operand		Reclosing start condition setting
5. STOP CON	EasyLogic operand		Reclosing stop condition setting
6. PRE TIME	0.05 ~ 200.00(0.01)	sec	Reclosing prepare time setting
7. DISC TIME	0.01 ~ 5.00(0.01)	sec	Circuit breaker operating discriminating time setting
8. RECL TIME	0.01 ~ 350.00(0.01)	sec	Reclosing reclaim time setting
9. 1^{ST} ~4^{TH} DELAY	0.01 ~ 300.00(0.01)	sec	Reclosing injection delay time setting
13. BLOCK	EasyLogic operand		Protection blocking condition
14. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
RECL	Auto reclosing counter
79_READY	Auto reclosing ready
79_IN_PROG	Auto reclosing progress
79_FAIL	Auto reclosing fail
79_SUCCESS	Auto reclosing success

3.2.12 Circuit Breaker Fail Protection(50BF)

After circuit breaker fail protection passes fault exclusion expectation time after relay displays trip signal to circuit breaker for fault origination, in case current passes continually, it is the second protection element that do it so that may act circuit breaker of high position system by circuit breaker fail signal and does so that remove fault.

When phase current (IA, IB, IC) is more than Pickup after expectation trip delay time passes moving to set Trip point of contact, relay acts. Trip contact output setting is possible to CONTACT OUTPUT#1 ~ CONTACT OUTPUT#6, CONTACT INPUT#1 ~ CONTACT INPUT#16.

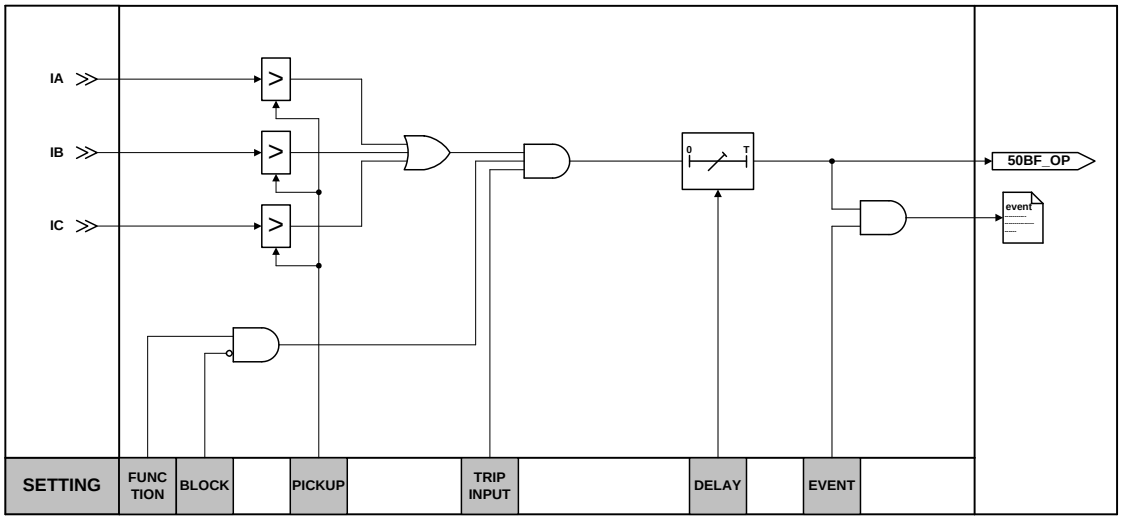


Figure 3-24 Circuit breaker fail protection operating characteristic

SETTING/ PROTECT#1~#4/ CBF(50BF)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. TRIP INPUT	CONT OUT#1~#6, CONT IN#1~#16		Trip input contact
3. PICKUP	0.20 ~ 2.50(0.01)	A	Current Pickup
4. DELAY	0.00 ~ 60.00(0.01)	sec	Function start delay time after Trip output
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
50BF_OP	Circuit breaker fail protection operation

3.2.13 Phase direction detection(67)

Phase direction detection element applies to distinguish stationary state in distribution power grounded system or direction of current flowing in fault condition. If establish output to 'BLOCK' of overcurrent protection element, relay acts about fault of specification direction. Phase direction detection element phase and 90 of phase current compare phase of elected line voltage and distinguish direction. When it is 3-phase short circuit fault near PT, to prevent malfunction by voltage loss, relay has memory voltage function. Direction distinction conversion minimum time is 40msec and direction detection minimum voltage is 3V, and direction detection minimum current is more than 0.05A. Voltage memory is 1sec after 3-phase voltage loss.

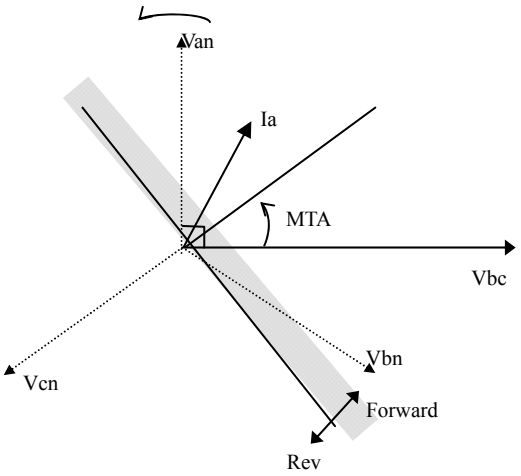


Figure 3-25 Direction property when produce A-phase fault

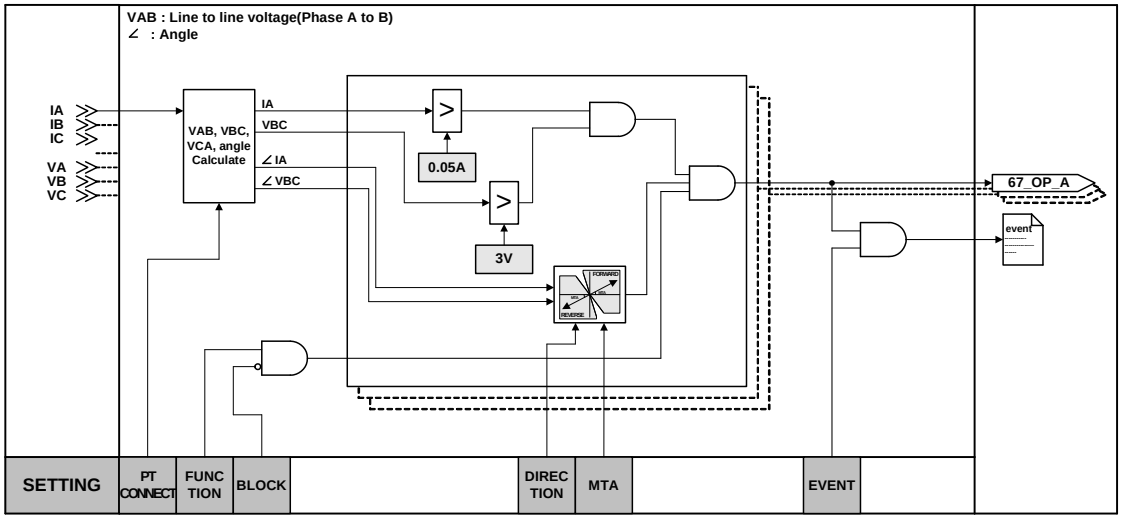


Figure 3-26 Phase direction detection operating characteristic

Direction distinction phase

Direction	Phase	Reference voltage phase (Vpol)	Phase characteristic
FORWARD	A	Vbc	Cosine(∠ Vpol + MTA - ∠ IA) ≥ 0
	B	Vca	Cosine(∠ Vpol + MTA - ∠ IB) ≥ 0
	C	Vab	Cosine(∠ Vpol + MTA - ∠ IC) ≥ 0
REVERSE	A	Vbc	Cosine(∠ Vpol + MTA - ∠ IA) < 0
	B	Vca	Cosine(∠ Vpol + MTA - ∠ IB) < 0
	C	Vab	Cosine(∠ Vpol + MTA - ∠ IC) < 0

SETTING/ PROTECT#1~#4/ PHS DIR(67)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. DIRECTION	FORWARD, REVERSE		Direction setting FORWARD REVERSE
3. MTA	-90 ~ +90(1)	°	Maximum torque angle setting
4. BLOCK	EasyLogic operand		Protection blocking condition
5. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
IA, IB, IC	Secondary phase current magnitude, angle
Vbc, Vca, Vab	Secondary line to line voltage magnitude, angle
67_OP_A, B, C	Phase direction detection A, B, C Phase operation

3.2.14 Ground direction detection(67N)

Ground direction detection detection element applies to distinguish stationary state in grounded system or direction of current flowing in fault condition. If establish output to 'BLOCK' of ground overcurrent protection element, relay acts about fault of specification direction. Ground direction detection element compares voltage phase (3V0, VG) or ground current (IN) and distinguishes direction with phase of vector sum (I0) of three-phase current according to polarizing setting. Direction distinction conversion minimum time is 40msec, and direction detection minimum current is more than 0.05A.

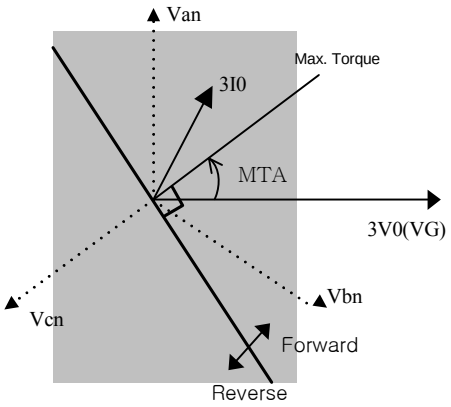


Figure 3-27 Ground direction detection characteristic

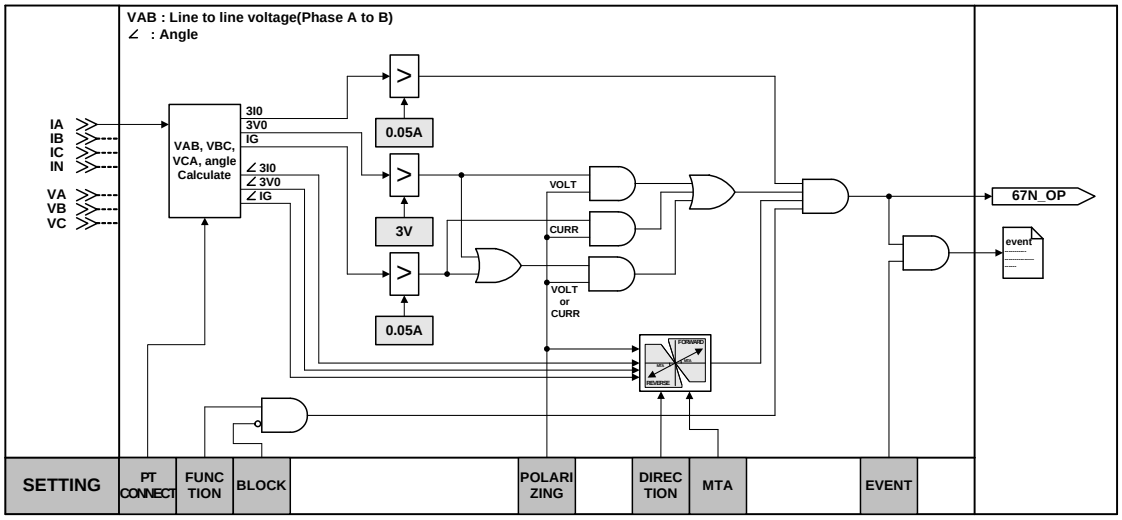


Figure 3-28 Ground direction detection operating characteristic

Direction distinction phase

Direction	Polarizing	Input voltage phase (Vpol)	Phase characteristic
FORWARD	VOLT	3V0/VG	Cosine(∠Vpol + MTA - ∠3I0) ≥ 0
	CURR	IN	Cosine(∠Vpol - ∠3I0) ≥ 0
REVERSE	VOLT	3V0/VG	Cosine(∠Vpol + MTA - ∠3I0) < 0
	CURR	IN	Cosine(∠Vpol - ∠3I0) < 0

SETTING/ PROTECT#1~#4/ GND DIR(67N)

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. DIRECTION	FORWARD, REVERSE		Direction setting FORWARD REVERSE
3. POLARIZING	VOLT, CURR, VOLT OR CURR		Reference polarizing setting VOLT : Voltage reference CURR : Current reference VOLT OR CURR : Voltage or current reference
4. VOLT SRC	3VO, VG		Input voltage setting 3V0 : Zero sequence voltage VG : N Phase voltage
5. MIN VOLT	5 ~ 170(1)	V	Minimum voltage setting
6. MTA	-90 ~ +90(1)	°	Maximum torque angle setting
7. BLOCK	EasyLogic operand		Protection blocking condition
8. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
I0	Secondary zero sequence current magnitude, angle
IN	Secondary N Phase current magnitude, angle
V0	Secondary zero sequence voltage magnitude, angle
VG	Secondary N Phase voltage magnitude, angle
67N_OP	Ground direction detection operation

3.2.15 Cold Load Pickup(COLDLD)

Inrush current when it is line, transformer and reactor etc are injected can lead to malfunction to exceed setting value of time of normal operation of protection element. Can achieve most suitable protection that Cold Load Pickup element applies setting value of protection element high during setup time from injection detecting closing time and stationary state applies proper form setting value. Relay has operation delay time and acts in case of it is below size that phase current (IA, IB, IC) is set all, and relay has reset delay time and returns in case of it is more than size that current more than 1 among phase current is set.

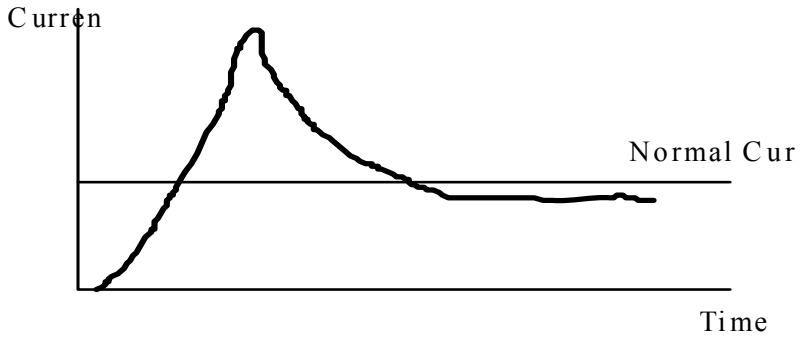


Figure 3-29 Cold Load Pickup current shape

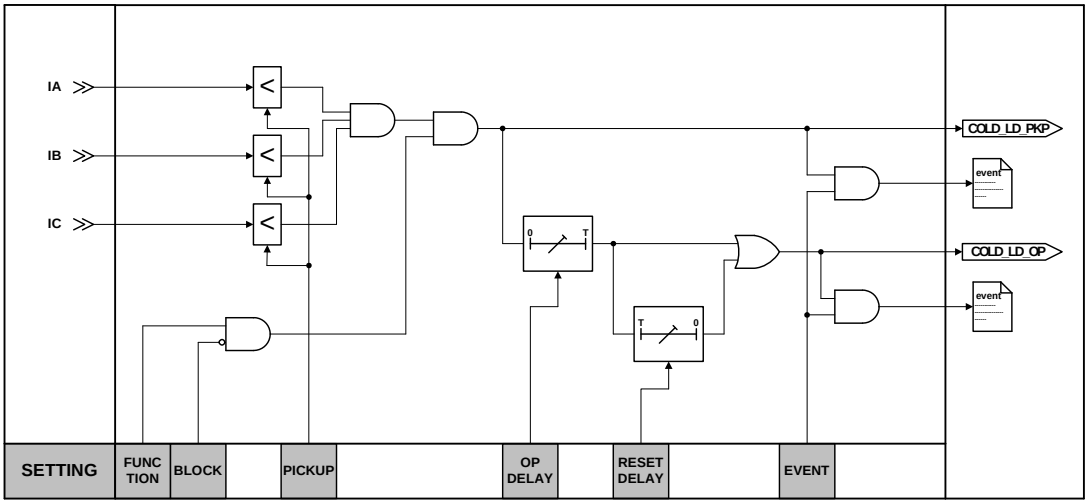


Figure 3-30 Cold Load Pickup operating characteristic

SETTING/ PROTECT#1~#4/ COLD LD

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. PICKUP	0.10 ~ 5.00 (0.01)	A	Cold Load Pickup current
3. OP DELAY	0~1000(1)	sec	Operation delay time
4. RESET DELAY	0~1000(1)	sec	Reset delay time
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
COLD_LD_PKP	Cold Load Pickup detect Pickup
COLD_LD_OP	Cold Load Pickup detect Operation

3.2.16 Inrush Detection

Inrush current detection element is used into expenditure that prevent malfunction of protection element from inrush current that occur when it is pressurization of long-distance line, transformer, reactor etc. When inrush current detection element is more than size that fundamental wave current (I1f) is set, and ratio of 2 harmonics current (I2f) and fundamental wave current is more than setting value, it is acting instantaneous/definite time element. Relay can control protection element operation during inrush current detection through 'Block' setting that is to each protection element.

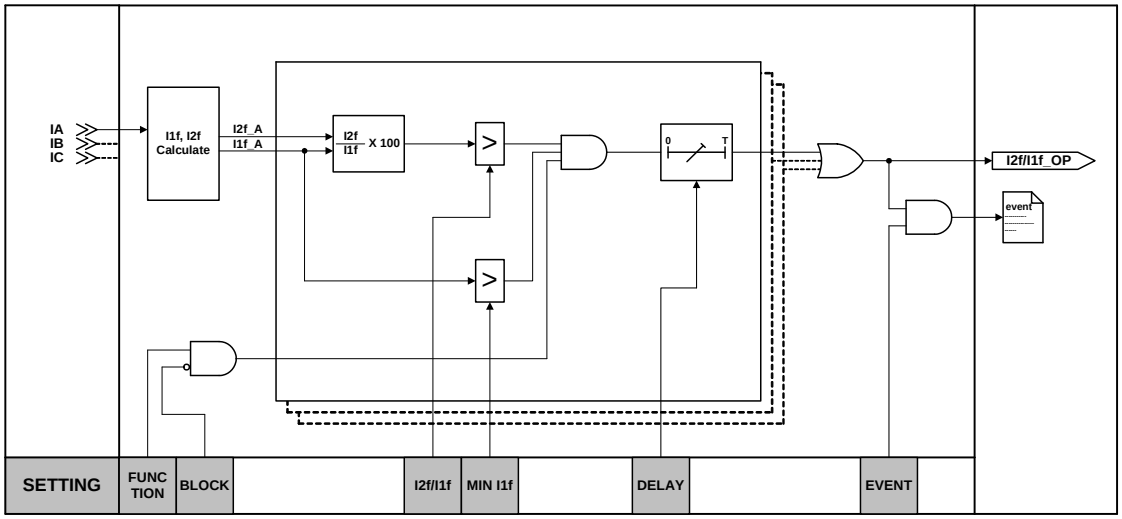


Figure 3-31 Inrush current detection operating characteristic

SETTING/ PROTECT#1~#4/ INRUSH

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether fuction use or not
2. I2f/I1f	10 ~ 100% (1)	%	(2 harmonics current / fundamental wave current)*100
3. MIN I1f	0.10 ~ 2.50(0.01)	A	fundamental wave minimum operating current
4. DELAY	0.00 ~ 60.00(0.01)	sec	Operating time delay
5. BLOCK	EasyLogic operand		Protection blocking condition
6. EVENT	ENABLED, DISABLED		Whether event record or not

Metering and EasyLogic Operand

LCD display Item	Description
I1f	Secondary Fundamental wave phase current
I2f	Secondary 2 harmonics phase current
I2f/I1f_OP	Inrush current detection operation

3.3 Subsidiary Function

3.3.1 Record

Event/Fault record

Relay can record event & fault recording up to 1024. All events record with information occurrence time by resolution of 1msec.

Event/Fault items are power On/Off, protection operation status, digital input/output status, CB control, setting change, monitoring/diagnostic status, event data clear, waveform data clear, energy data clear, thermal data clear, circuit breaker output counter change etc. When it is protection element operation status change, relay records together fault information.

- Frequency of A-Phase voltage, Secondary magnitude (If PT wiring is 'NONE', frequency is A-Phase current)
- Voltage A, B, C, N Phase Secondary magnitude, angle
- Current A, B, C, N, Is Phase Secondary magnitude, angle

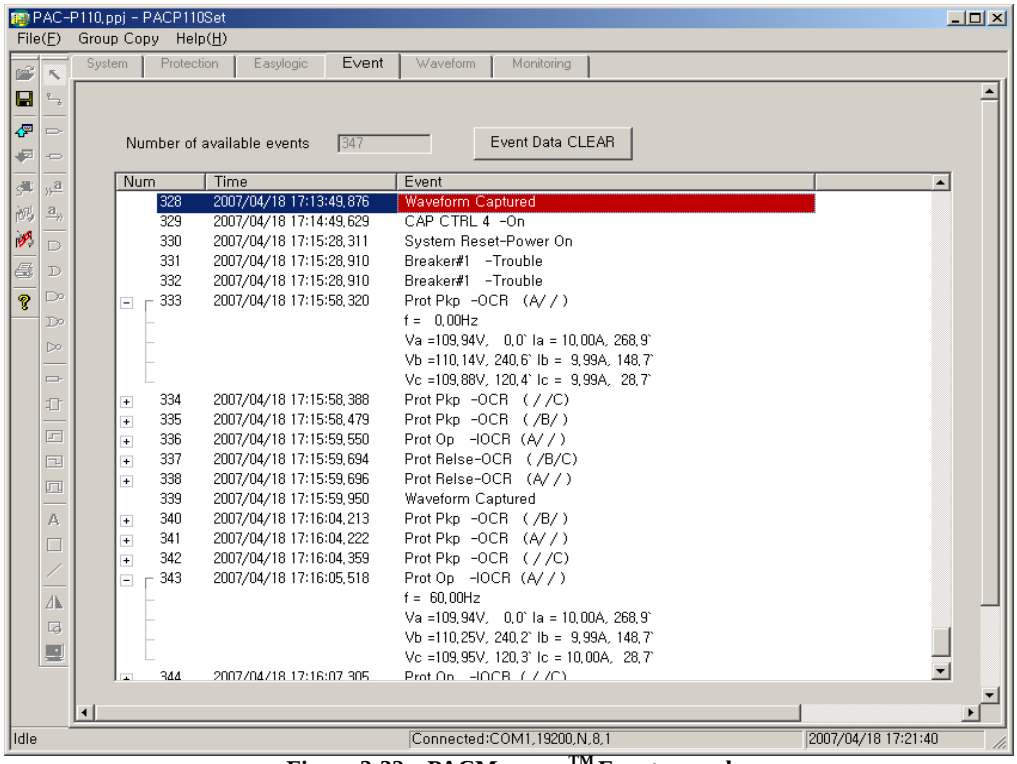


Figure 3-32 PACManager™ Event record

Recorded events are listed up in LCD, and uploaded to PACManager ™ locally or by SCADA remotely. Event recording is kept even if power of relay is lost.

Waveform record

PAC-F100 has fault oscillograph function up to 8 waveforms with 64 sampling rate in non-volatile memory. Waveform has maximum 4 second recording time, where current, voltage, I/O contacts, protection element status are included.

Trigger condition to start recording can be I/O contact status change, protection element operation, and combination of internal logic configuration by EasyLogic™. And trigger position can be set in 0~99% location of total waveform size.

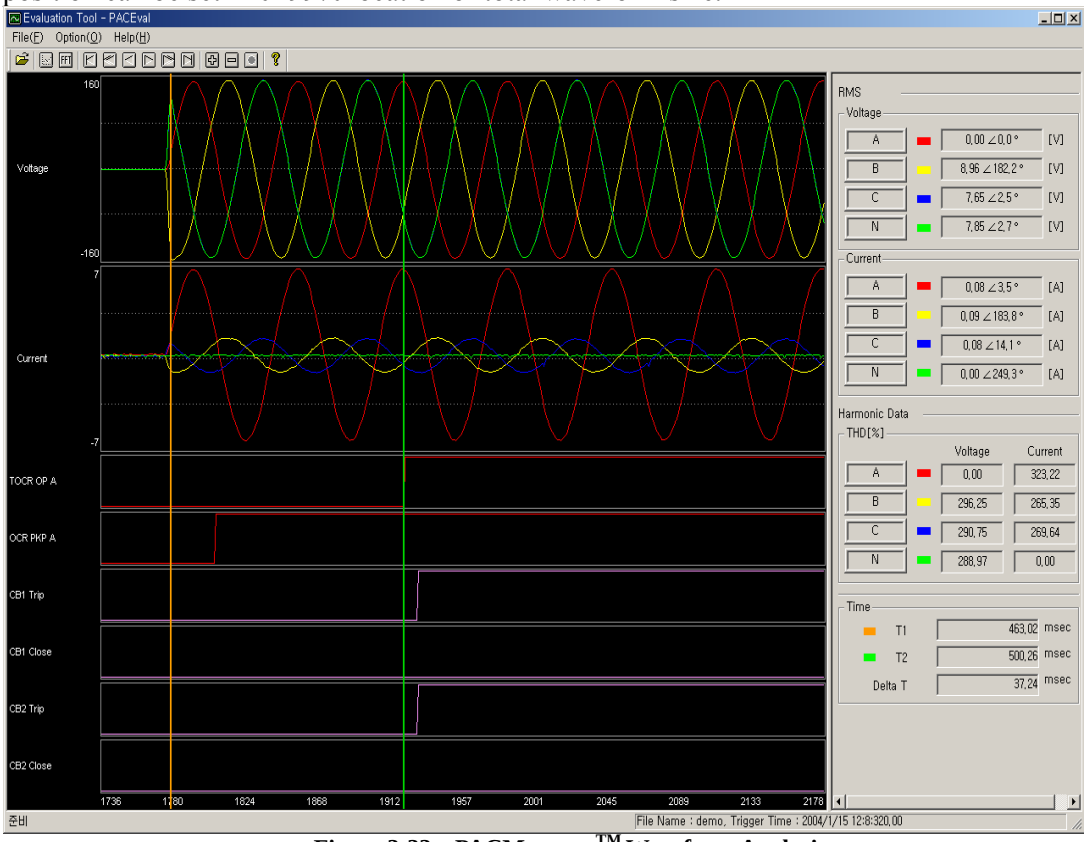


Figure 3-33 PACManager™ Waveform Analysis

Recorded waveform are listed up in LCD, and uploaded to PACManager ™ locally or by SCADA remotely. Waveform recording is kept even if power of relay is lost. Waveform is of COMTRADE file format so that it can be used for fault simulation with fault analysis and relay test equipment.

SETTING/ SYSTEM/ WAVEFORM RECORD

Setting Item	Step	Unit	Description
1. TYPE	8*50, 4*100, 2*200	Cycle	Waveform save number and capacity 8*50 : 8 Number, 50cycle
2. TRIGGER SRC	EasyLogic operand		Trigger source setting
3. TIRGGER POS	.0 ~ 99% (1)	%	Trigger position setting 40% : Waveform(40%) before trigger + waveform(60%) after trigger

MIN/MAX Record

Cycle of MIN/MAX record is 100ms. Primary value of line to line voltage, current by phase, 3Phase real/reactive/apparent power, 3Phase power factor, demand current by phase, 3Phase demand real/reactive/apparent power, frequency is recorded with occurrence time to MIN/MAX record.

Relay can upload in local through PACManager ™ or remote. Waveform recording is kept even if power of relay is lost.

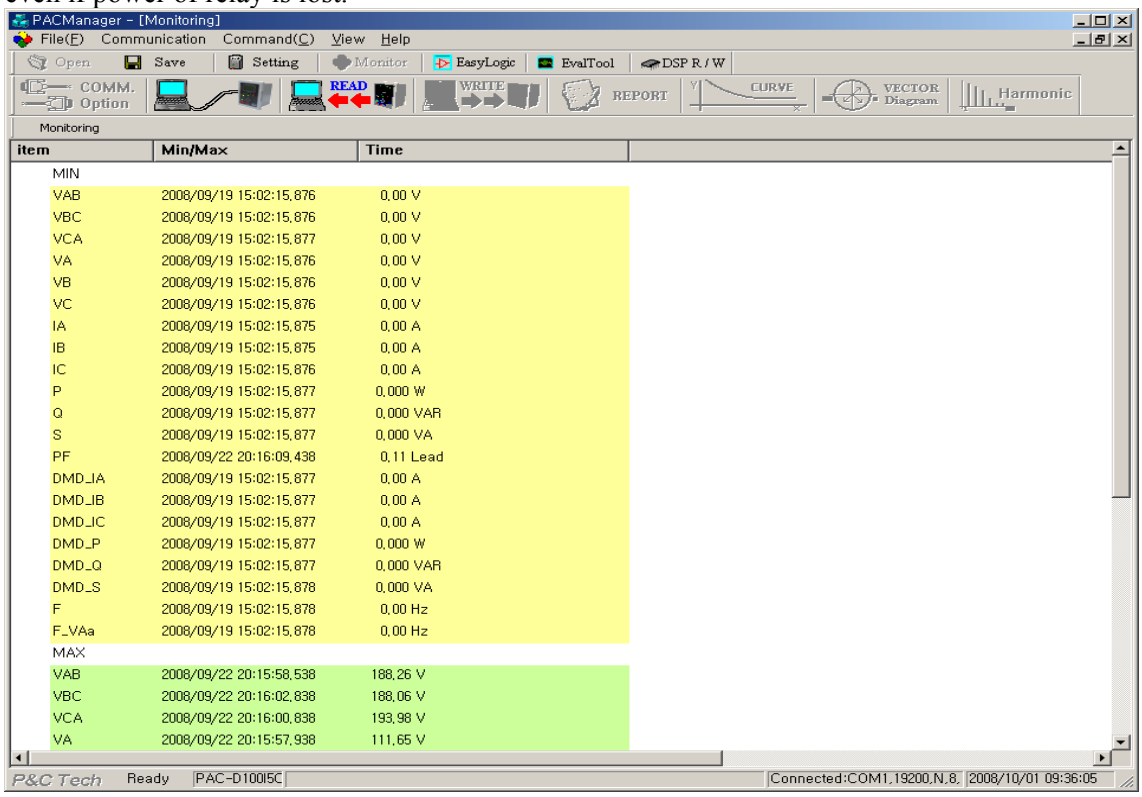


Figure 3-34 PACManager™ MIN/MAX record

3.3.2 Circuit breaker control

Relay can set up necessary setting to control circuit breaker 2 in SETTING/SYSTEM/BREAKER. ID of circuit breaker can set 12 characters. Each character should be set by English upper/lower-case, digit, spatial character registered to keyboard.
Each circuit breaker status can use one of 52a and 52b by contact input, or use everybody by contact input. Mark status of circuit breaker according to status of contact input in case of use contact input 1, relay marks status of circuit breaker according to 2 contact input statuses in case of use 2 by contact input. If use 2 digital inputs, can not control circuit breaker judging that problem is to point of contact connection of circuit breaker or circuit breaker if status of point of contact is same.
Confirm function use availability of digital input and connection status that is set and set of digital input in case of status of circuit breaker is registered as absurd.

SETTING/ SYSTEM/ BREAKER#1~#2

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. ID	ASCII		Circuit breaker ID, 12 character
3. TRIP PULSE	0.1 ~ 5.0(0.1)	sec	Circuit breaker Trip control pulse
4. CLOSE PULSE	0.1 ~ 5.0(0.1)	sec	Circuit breaker Close control pulse
5. 52a INPUT	NONE, CONT IN#1~CONT IN#16		Circuit breaker status(52A) contact input NONE : Circuit breaker status judgment by 52a
6. 52b INPUT	NONE, CONT IN#1~CONT IN#16		Circuit breaker status(52B) contact input NONE : Circuit breaker status judgment by 52b
7. KEY CTRL	ENABLED, DISABLED		Whether allowable local control for circuit breaker or not DISABLED : In local circuit breaker control prohibition

3.3.3 MONITORING

3.3.3.1 PT FUSE FAILURE

Zero-seq Voltage occurs in case of each phase loss of PT secondary side and causes mal-operations of Directional element and Under Voltage element. PAC-x100 supervises PT secondary circuit monitoring Zero-seq Current as well as Zero-seq Voltage occurrences. This function cannot be applied to small earth fault current such as in ungrounded or high resistance grounded system. This function is automatically disabled in Delta connection of PT setting.

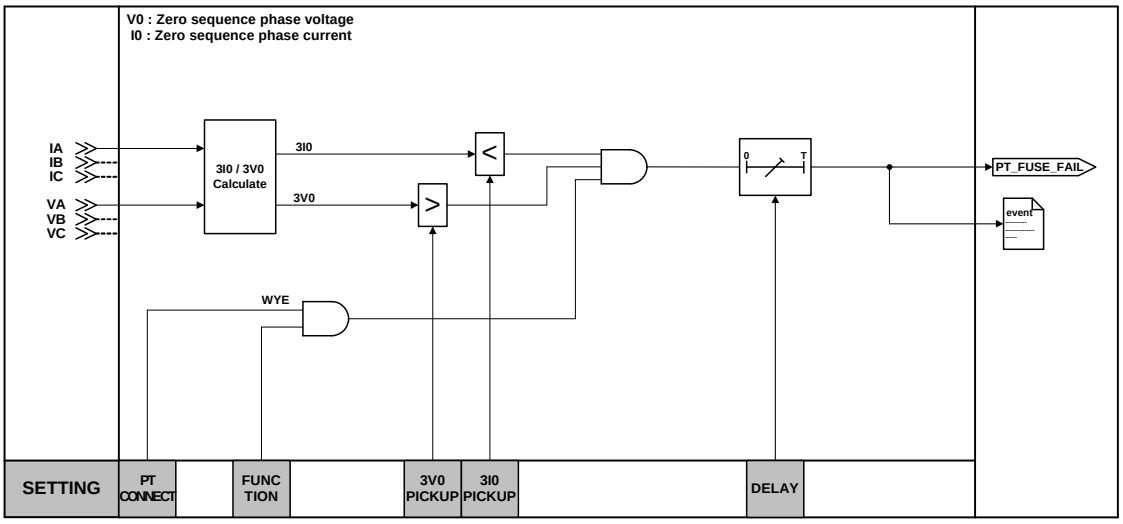


Figure 3-35 PT fuse failure operating characteristic

SETTING/ SYSTEM/ MONITORING/ PT FUSE FAILURE

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. 3V0 PICKUP	10 ~ 190(1)	V	3V0 Pickup setting
3. 3I0 PICKUP	0.10 ~ 5.00(0.01)	A	3I0 Pickup setting
2. DELAY	0.00 ~ 60.00(0.01)	sec	Operation delay time

Metering and EasyLogic Operand

LCD display Item	Description
I0	Secondary Zero sequence current magnitude
V0	Secondary Zero sequence voltage magnitude
PT_FUSE_FAIL	PT fuse failure operation

3.3.3.2 Current input circuit monitor (CURRENT SUM)

Current Input Circuit is monitored by the difference between vector sum of 3-phase CT current inputs and ground CT current input. (3I0 - Ig) / Imax > Current Sum Factor, for 3I0 – Ig > Current Sum Threshold

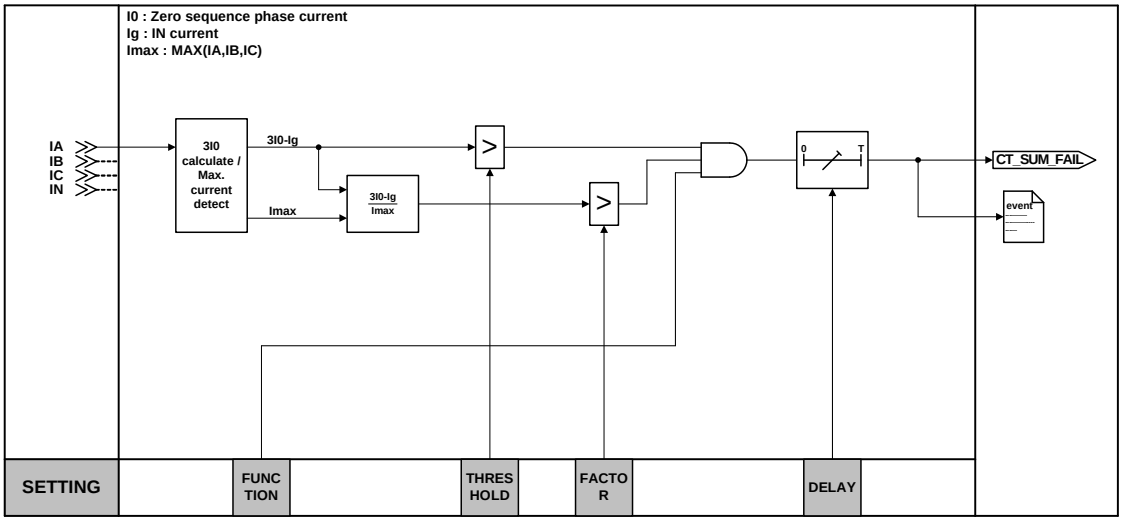


Figure 3-36 Current input circuit monitor operating characteristic

SETTING/ SYSTEM/ MONITORING/ CURRENT SUM

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. THRESHOLD	0.10 ~ 10.00(0.01)	A	Threshold current setting
3. FACTOR	0.10 ~ 0.90(0.01)		Factor setting
2. DELAY	0.00 ~ 60.00(0.01)	sec	Operation delay time

Metering and EasyLogic Operand

LCD display Item	Description
I0	Secondary Zero sequence current magnitude
Ig	Secondary N-Phase current magnitude
CT_SUM_FAIL	Current input circuit monitor operation

3.3.3.3 Voltage unbalance monitor (VOLTAGE BALANCE)

Voltage Unbalance is operated when the ratio of minimum phase voltage to maximum phase voltage is less than setting ratio value. Voltage Unbalance is blocked when any protection element pickup is operated.

|Vmin/|Vmax| < Voltage Balance Factor, for Vmax > Voltage Balance Threshold

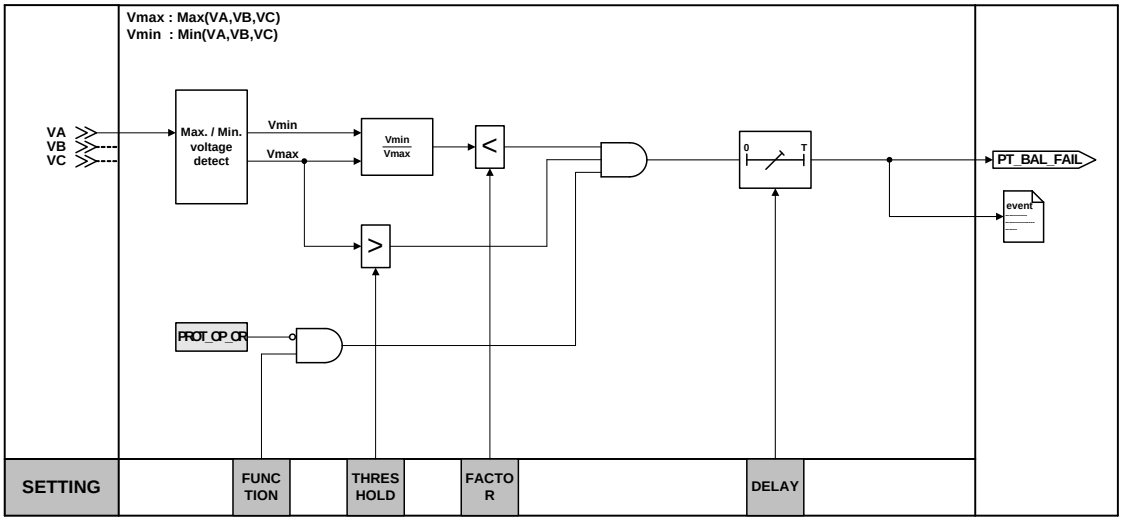


Figure 3-37 Voltage unbalance monitor operating characteristic

SETTING/ SYSTEM/ MONITORING/ VOLTAGE BALANCE

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. THRESHOLD	10 ~ 150(1)	V	Threshold voltage setting
3. FACTOR	0.10 ~ 0.90(0.01)		Factor setting
2. DELAY	0.00 ~ 60.00(0.01)	sec	Operation delay time

Metering and EasyLogic Operand

LCD display Item	Description
PT_BAL_FAIL	Voltage unbalance monitor operation

3.3.3.4 Current unbalance monitor (CURRENT BALANCE)

Current Unbalance is operated when the ratio of minimum phase current to maximum phase current is less than setting ratio value. Current Unbalance is blocked when any protection element pickup is operated.

|Imin/|Imax| < Current Balance Factor, for Imax > Current Balance Threshold

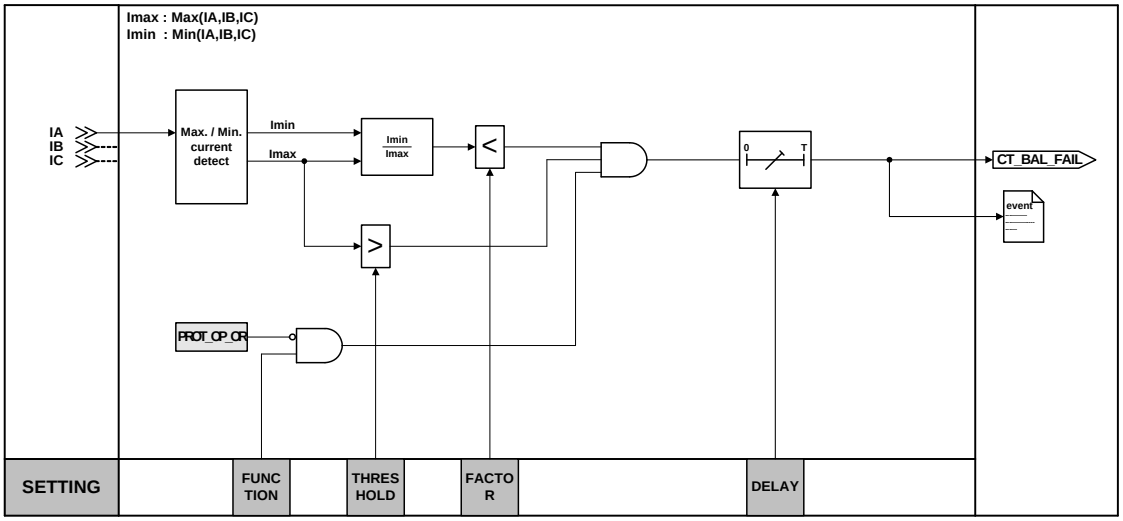


Figure 3-38 Current unbalance monitor operating characteristic

SETTING/ SYSTEM/ MONITORING/ CURRENT BALANCE

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. THRESHOLD	0.10 ~ 10.00(0.01)	A	Threshold current setting
3. FACTOR	0.10 ~ 0.90(0.01)		Factor setting
2. DELAY	0.00 ~ 60.00(0.01)	sec	Operation delay time

Metering and EasyLogic Operand

LCD display Item	Description
CT_BAL_FAIL	Current unbalance monitor operation

3.3.3.5 Trip circuit supervision (TCS)

This is alarming function is case the status of a contact input feedback from trip contact output keeps "0" status for more than 5 minutes. To monitor without CB open/close status information, CB aux contacts (52a, 52b) and resistance are required.

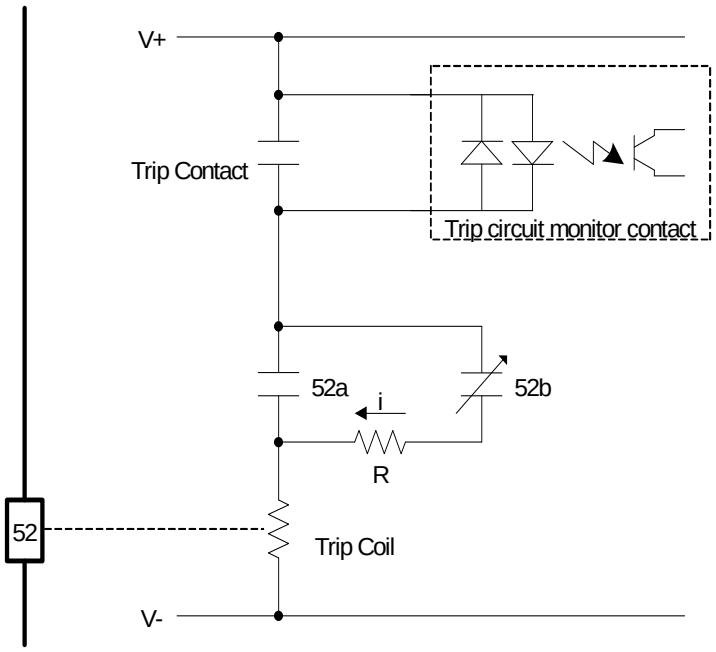


Figure 3-39 TCS circuit composition

SETTING/ SYSTEM/ MONITORING/ TCS

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. TRIP INPUT	CONTIN#1 ~CONT IN#16		Trip input

Metering and EasyLogic Operand

LCD display Item	Description
TCS_FAIL	TCS operation

3.3.4 Demand

Relay sets demand's interval, update number of times, sync time and measures demand of three-phase current, real/reactive/apparent power.

SETTING/ SYSTEM/ MONITORING/ TCS

Setting Item	Step	Unit	Description
1. INTERVAL	15, 30, 60	min	Interval setting
2. UPDATE	1 ~ 15(1)		Update number setting
3. SYNC TIME	0, 15, 30, 45	min	Sync time setting

3.3.5 Communication

SETTING/SYSTEM/COMMUNICATION sets that need in 2 RS485 communications that is situated to relay rear. Appear in 2 RS485 communication port settings and DNP3.0 protocol setting screen in case of DNP3.0 protocol is included product. Appear in 2 RS485 communication port setting screens in case of IEC60870-5-103 protocol is included product. COM2 is Modbus protocol dedicated, and protocol change is possible COM1.

Should do power Off/On certainly after store setting if change COM#1's protocol.(Reflection does not become by protocol that change power if do not Off/On.)

SETTING/ SYSTEM/ COM#1~#2

Setting Item	Step	Unit	Description
1. FUNCTION	ENABLED, DISABLED		Whether function use or not
2. BPS	300, 1200, 2400, 4800, 9600, 19200, 38400		Bit/sec
3. SLAVE ADDR	1~65534(1)	sec	Slave address Modbus, IEC60870-5-103 (1~254)
4. PROTOCOL	ModBus,DNP3.0 or Modbus,IEC60870-5-103	sec	Application communication protocol Differ according to ordering option

SETTING/ SYSTEM/ DNP3.0

Setting Item	Step	Unit	Description
1. TX DELAY	0 ~ 65000(1)	msec	Tx delay time
2. LINK CONFIRM	NEVER, ALWAYS, SOMETIMES		Link layer confirm
3. LINK RETRY	0~5(1)		Link layer retry count
4. LINK TIMEOUT	1 ~ 65000(1)	msec	Link layer timeout
5. SBO TIMEOUT	1 ~ 65000(1)	msec	SBO timeout
6. WR TIME INT	1 ~ 65000(1)	min	Write time interval
7. COLD RESTART	ENABLED, DISABLED	sec	Cold restart.

3.3.6 SYSTEM Time

System time may set in local or remote through communication.

SETTING/SYSTEM/RTC is used to change system time that is placed inside protective relay. Setting order is order year/month/day/hour:minute:second.

Select each item by left(<), right(>) key, and changes value by up(^), down(v) key. If press ENTER key, time is set.

SETTING/ SYSTEM/ RTC

Setting Item	Step	Unit	Description
YYYY	2000 ~ 2100(1)		Year
MM	01~12(1)		Month
DD	01~31(1)		Day
HH	00~23(1)		Hour
MM	00~59(1)		Minute
SS	00~59(1)		Second

4 Application example

4.1 Wiring and setting

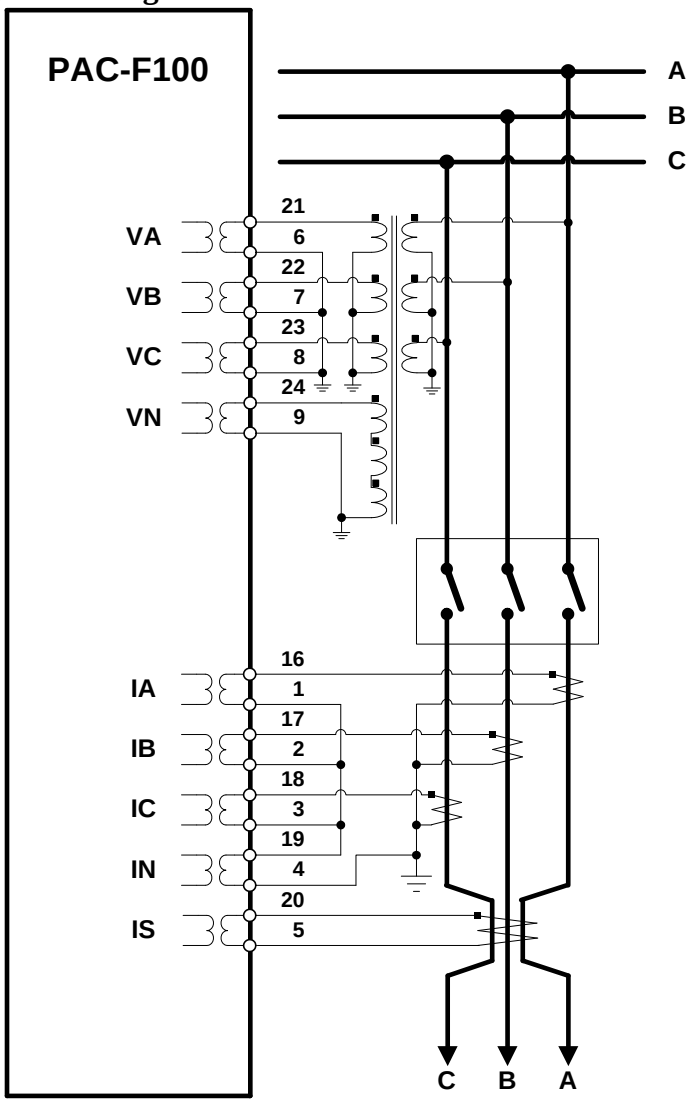


Figure 4-1 Application example wiring

Table 4-1 Application example POWER SYSTEM setting

Power System	Setting	Unit
1. FREQUENCY	60Hz	
2. PT CONNECT	WYE	
3. PHS PT PRI	3.30	kV
4. PHS PT SEC	110	V
5. GND PT PRI	1.10	kV
6. GND PT SEC	110	V
7. PHS CT RATIO	300:5	
8. GND CT RATIO	300:5	
9. SET GROUP	GROUP#1	

Set SETTING/POWER SYSTEM like table 4-1 and inputs current/voltage.

4.2 Measurement

Current/Voltage input

Terminal	Input value
FREQUENCY	60Hz
VA	110, 0.0 º
VB	110, 240.0 º
VC	120, 120.0 º
VN	30, 120.0 º
IA	1.00 A, 0.0 º
IB	2.00 A, 240.0 º
IC	3.00 A, 120.0 º
IN	1.72 A, 151.5 º
Is	1.5mA, 0.0 º
Injection time	24Hours

Primary current/voltage/frequency/Sequence current display

Current/voltage magnitude reflects CT and PT Ratio setting and marks by primary current/voltage. Phase metering marks via A-phase voltage. (Via A-phase current in case of PT wiring is 'NONE' display)

- A-Phase voltage : (3300/110)*110 = **3300[V], 0.0 º**
- B-Phase voltage : (3300/110)*110 = **3300[V], 240.0 º**
- C-Phase voltage : (3300/110)*120 = **3600[V], 120.0 º**
- N-Phase voltage : (1100/110)*30 = **300[V], 30.0 º**
- 3-Phase average voltage : (3300+3300+3600)/3 = **3400[V]**
- AB Line voltage : (3300/110)*190.52 = **5715.6[V], 30.0 º**
- BC Line voltage : (3300/110)*199.24 = **5977.2[V], 271.5 º**
- CA Line voltage : (3300/110)*199.24 = **5977.2[V], 148.5 º**
- A-Phase current : (300/5)*1 = **60[A], 330.0 º**
- B-Phase current : (300/5)*2 = **120[A], 210.0 º**
- C-Phase current : (300/5)*3 = **180[A], 90.0 º**
- N-Phase current : (300/5)*1.72 = **103.2[A], 0.0 º**
- 3-Phase average current : (60+120+180)/3 = **120[A]**
- Is current : = **1.5[mA], 0.0 º'**

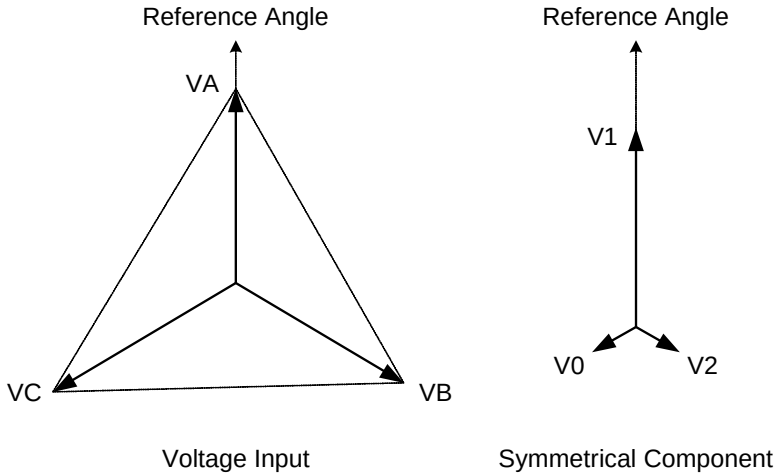


Figure 4-2 Sequence voltage

- Zero sequence voltage, $V0 = \frac{1}{3}(\dot{V}_A + \dot{V}_B + \dot{V}_C)$:(3300/110)*3.33 = **99.9[V],120.0 º**
- Positive sequence voltage, $V1 = \frac{1}{3}(\dot{V}_A + a\dot{V}_B + a^2\dot{V}c)$:(3300/110)*113.33= 3400[V], 0 º
- Negative sequence voltage, $V2 = \frac{1}{3}(\dot{V}_A + a^2\dot{V}_B + a\dot{V}c)$:(3300/110)*3.33= 99.9[V], 240 º

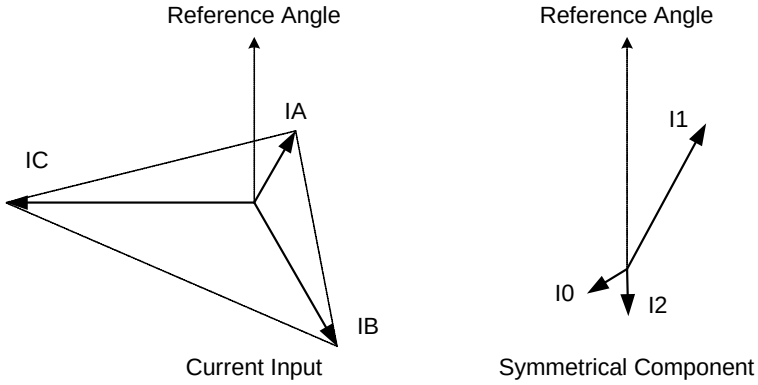


Figure 4-3 Sequence current

- Zero sequence current, $I0 = \frac{1}{3}(\dot{I}_A + \dot{I}_B + \dot{I}_C)$:(300/5)*0.57 = **34.2[A], 121.5 º**
- Positive sequence current, $I1 = \frac{1}{3}(\dot{I}_A + a\dot{I}_B + a^2\dot{I}c)$:(300/5)*2 = 120[A], 331.5 º
- Negative sequence current, $I2 = \frac{1}{3}(\dot{I}_A + a^2\dot{I}_B + a\dot{I}c)$:(300/5)*0.57= 34.2[A], 181.5 º

4.3 Real/Reactive/Apparent power measurement

Real Power

- A-Phase : (3300/110)*110*(300/5)*1*cosine(30º) = **171473[W]**
- B-Phase : (3300/110)*110*(300/5)*2*cosine(30º) = **342946[W]**
- C-Phase : (3300/110)*120*(300/5)*3*cosine(30º) = **561184[W]**
- 3-Phase : 171473+342946+561184 = **1075603[W]**

Reactive Power

- A-Phase : (3300/110)*110*(300/5)*1*sine(30º)= **99000[Var]**
- B-Phase : (3300/110)*110*(300/5)*2*sine(30º)= **198000[Var]**
- C-Phase : (3300/110)*120*(300/5)*3*sine(30º)= **324000[Var]**
- 3-Phase : 171473+342946+561184 = **621000[Var]**

Apparent Power

- A-Phase : (3300/110)*110*(300/5)*1 = **198000[VA]**
- B-Phase : (3300/110)*110*(300/5)*2 = **396000[VA]**
- C-Phase : (3300/110)*120*(300/5)*3 = **648000[VA]**
- 3-Phase : 171473+342946+561184 = **1242000[VA]**

4.4 Demand measurement

Demand metering is equal with current quantity of electricity metering that fixed quantity of electricity is inputted for 24 hours.

Current measurement

- A-Phase current : **60[A]**
- B-Phase current : **120[A]**
- C-Phase current : **180[A]**

Real/Reactive/Apparent power measurement

- 3-Phase real power : 1075603[W]
- 3-Phase reactive power : 621000[Var]
- 3-Phase apparent power : 1242000[VA]

4.5 ENERGIES measurement

Real power energy

- Input real power energy : 1075603*24 = **25814.472[kWh]**
- Output real power energy : 0*24 = **0[kWh]**

Reactive power energy

- Input reactive power energy : 621000*24 = **14900[kVarh]**
- Output reactive power energy : 0*24 = **0[kVarh]**

Apparent power energy

- 1242000*24 = **29808[kVAh]**

5 Install and External connection

5.1 Dimensioned Drawings

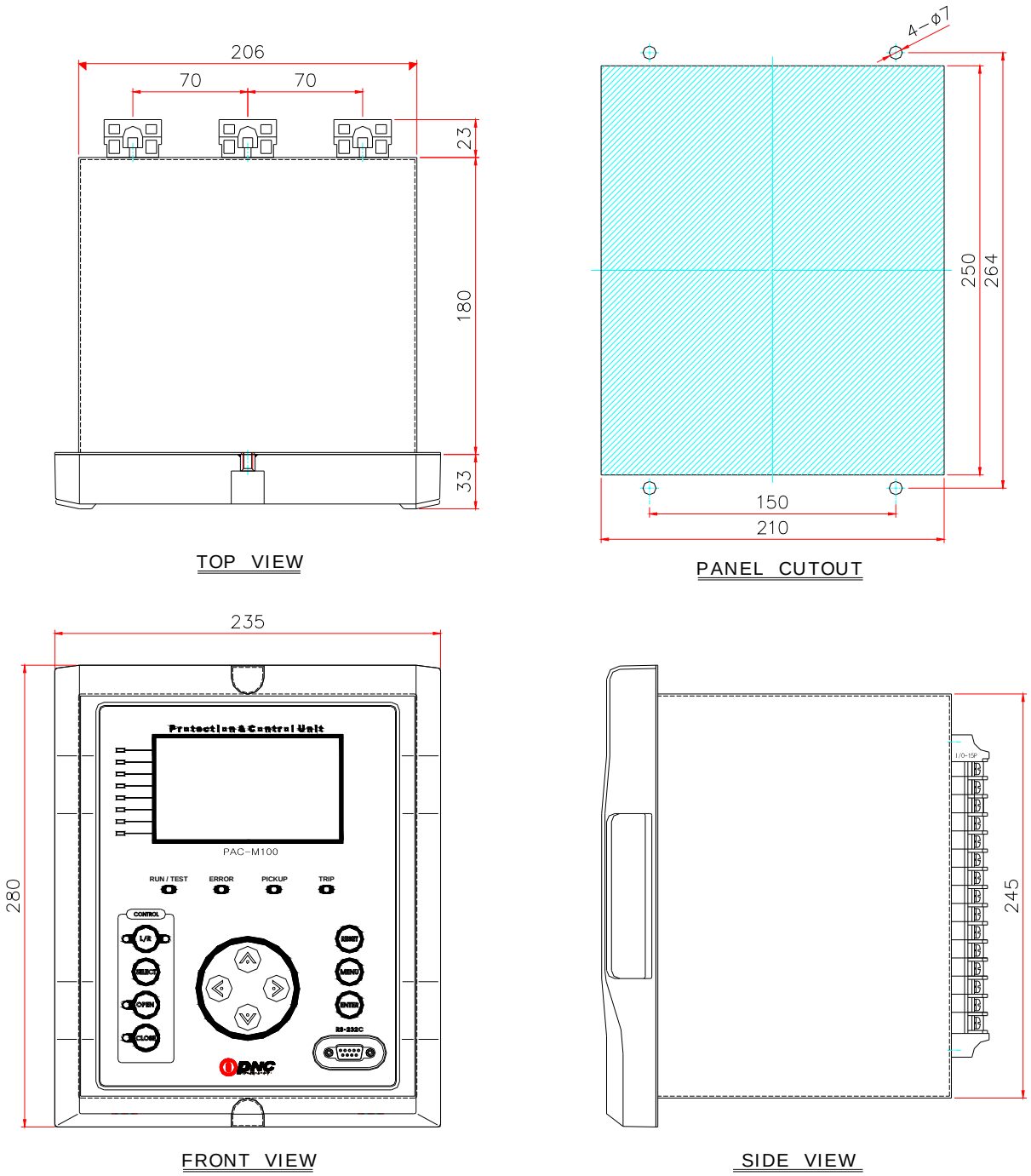
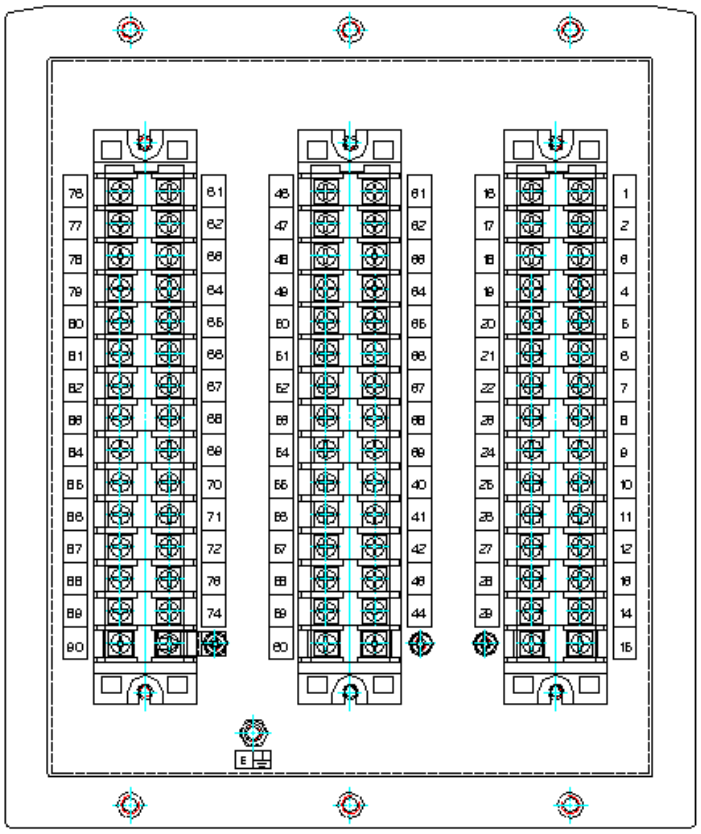


Figure 5-1 PAC-F100 Dimensioned Drawings

5.2 Rear terminal arrangement plan



REAR VIEW

Table 5-1 Terminal arrangement

76	TS1_COM	61	TS1_NO	46	DI1_COM	31	DI1_P	16	IA+	1	IA-
77	TS2_COM	62	TS2_NO	47	DI2_ COM	32	DI2_P	17	IB+	2	IB-
78	TS3_COM	63	TS3_NO	48	DI3_ COM	33	DI3_P	18	IC+	3	IC-
79	TS4_COM	64	TS4_NO	49	DI4_ COM	34	DI4_P	19	IN+	4	IN-
80	TS5_COM	65	TS5_NO	50	DI6_P	35	DI5_P	20	Is+	5	Is-
81	TS6_COM	66	TS6_NO	51	DI8_P	36	DI7_P	21	VA+	6	VA-
82	TS8_NO	67	TS7_NO	52	DI5_8_ COM	37	DI9_P	22	VB+	7	VB-
83	TS10_NO	68	TS9_NO	53	DI11_P	38	DI10_P	23	VC+	8	VC-
84	TS7_12COM	69	TS11_NO	54	DI9_12_ COM	39	DI12_P	24	VN+	9	VN-
85	TS13_NO	70	TS12_NO	55	DI14_P	40	DI13_P	25	-	10	-
86	TS13_16COM	71	TS14_NO	56	DI16_P	41	DI15_P	26	-	11	-
87	TS15_NC	72	TS15_NO	57	DI13_16COM	42	RS485_1D+	27	-	12	-
88	TS16_NC	73	TS16_NO	58	RS485_2D+	43	RS485_1D-	28	-	13	-
89	PWR+	74	SURGE	59	RS485_2D-	44	RS485_1COM	29	-	14	-
90	PWR-	75	CHASSIC	60	RS485_2COM	45	SURGE	30	SURGE	15	-

5.3 External Connections

5.3.1 PAC-F100 CT/PT connection

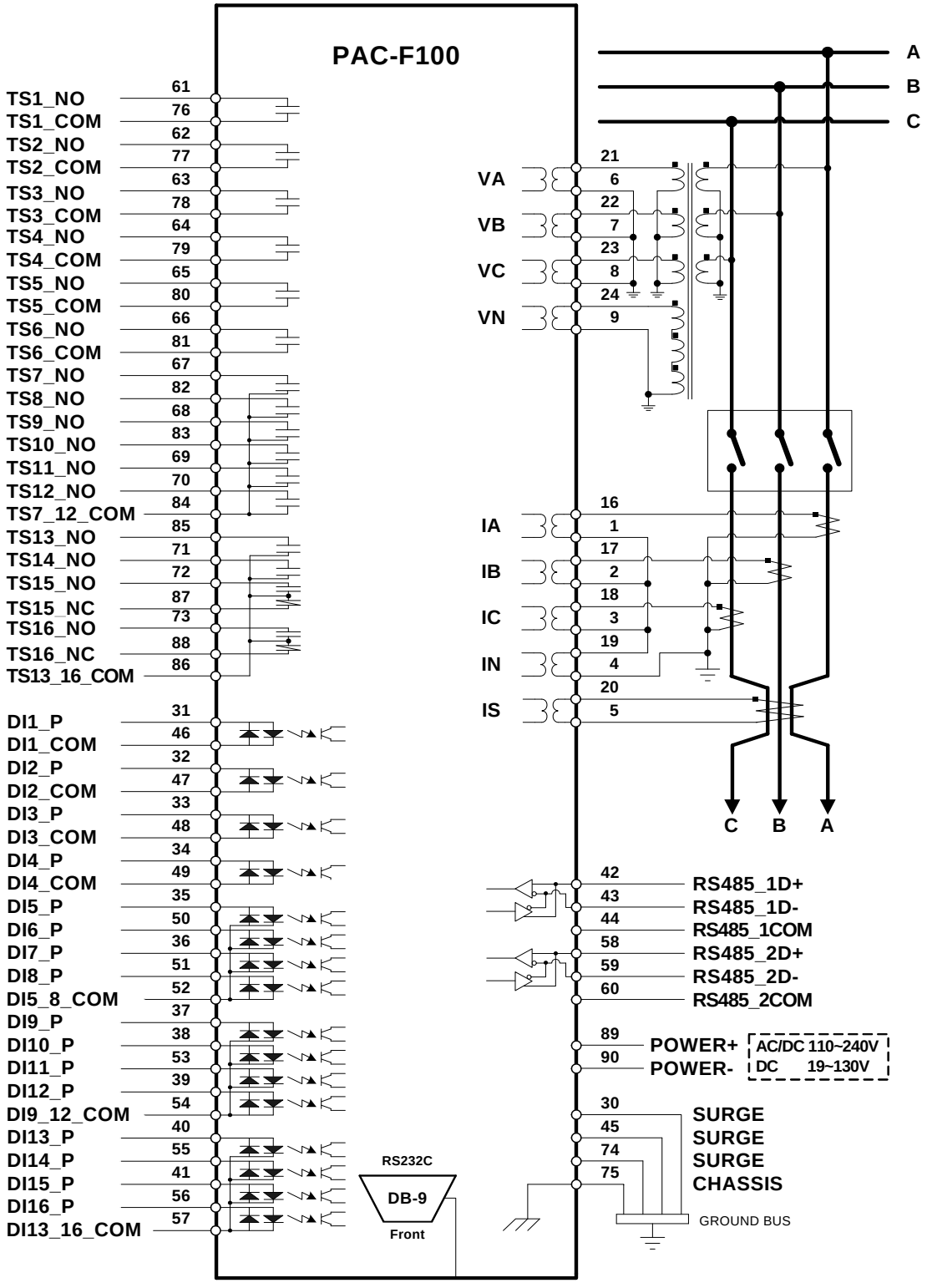


Figure 5-2 PAC-F100 CT/PT connection

5.3.2 Input/Output contact connection

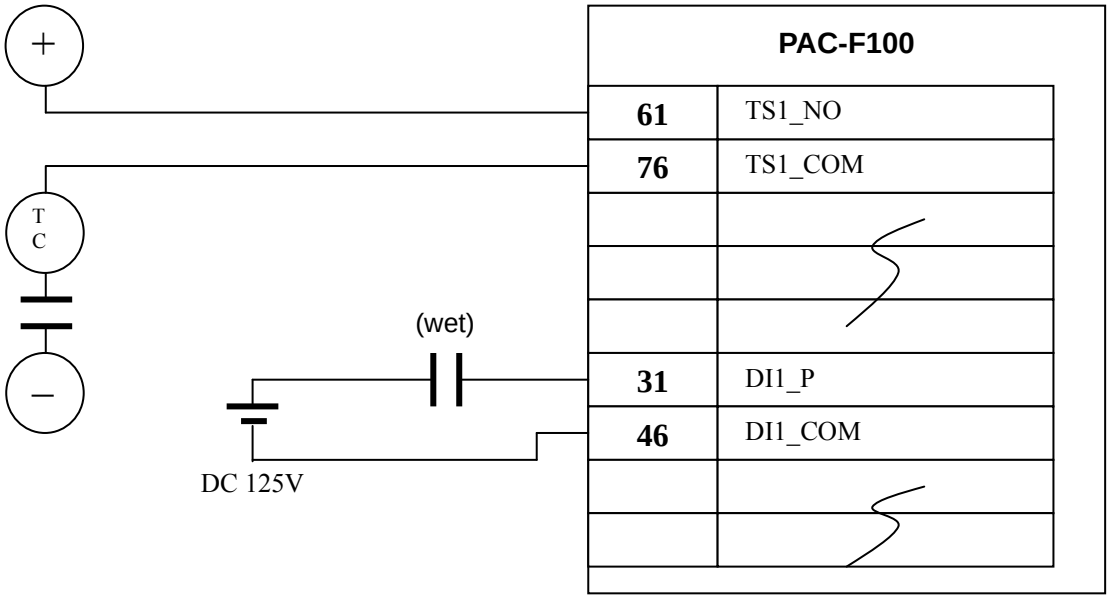


Figure 5-3 Input/Output contact connection

5.3.3 RS232 Port Connection

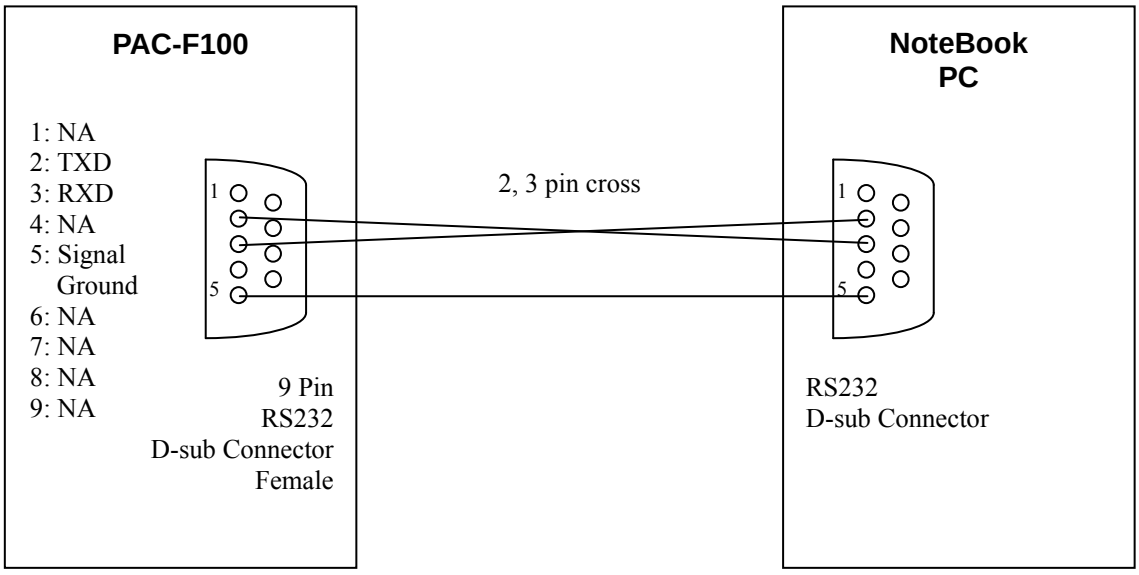


Figure 5-4 RS232 Port Connection

5.3.4 RS485 Port Connection

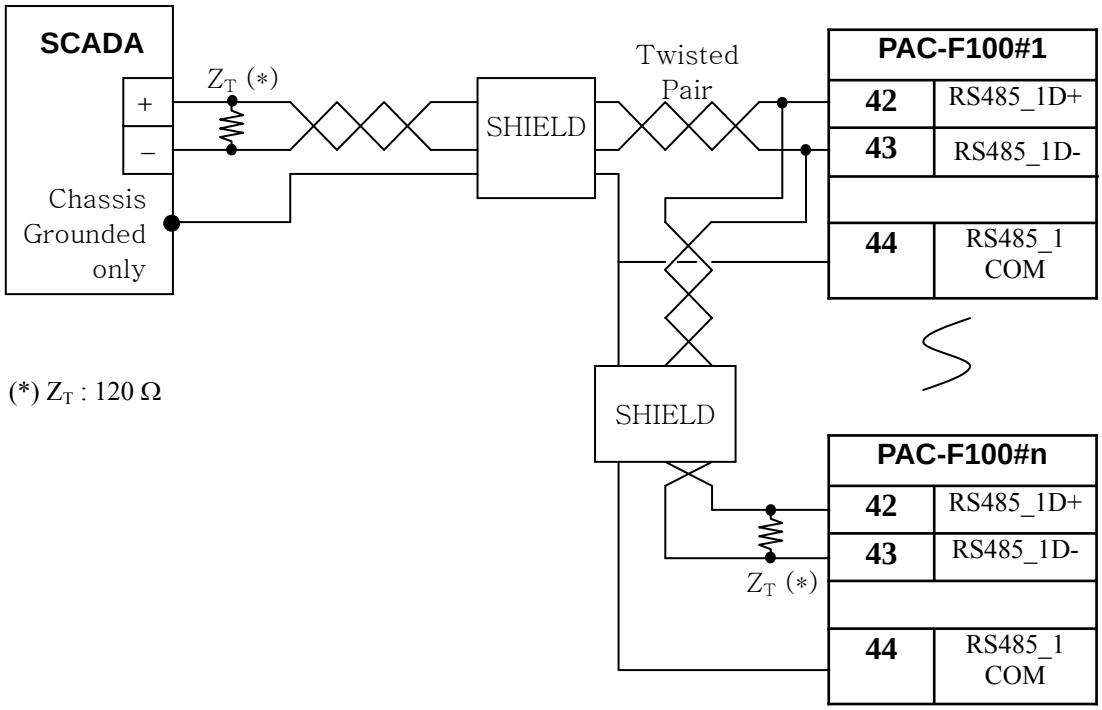


Figure 5-5 RS485 Port Connection

Appendix A. Time characteristics Curve

- Overcurrent/overvoltage

$$t = \left(\frac{K}{\left(\frac{G}{G_S} \right)^L - 1} + C \right) \times TM(\sec)$$

- Undervoltage

$$t = \left(\frac{K}{1 - \left(\frac{G}{G_S} \right)^L} \right) \times TM(\sec)$$

t : Operating time
K, C, L : Characteristic curve const
G : Current(voltage) input
Gs : Current(voltage) setting
TM : Multiplier(0.01~10.00)

Protection element	Inverse time curve	K	L	C
Phase/Ground Overcurrent(51/51N) Negative Sequence Overcurrent(46T)	IEC Normal Inverse	0.14	0.02	0.00
	IEC Very Inverse	13.50	1.00	0.00
	IEC Extremely Inverse	80.00	2.00	0.00
	IEC Long Inverse	120.00	1.00	0.00
	ANSI Inverse	8.9341	2.0938	0.17966
	ANSI Short Inverse	0.2663	1.2969	0.03393
	ANSI Long Inverse	5.6143	1	2.18592
	ANSI Moderately Inverse	0.0103	0.02	0.0228
	ANSI Very Inverse	3.922	2	0.0982
	ANSI Extremely Inverse	5.64	2	0.02434
	ANSI Definite Inverse	0.4797	1.5625	0.21359
	KEPCO Normal Inverse	0.11	0.02	0.42
	KEPCO Very Inverse	39.85	1.95	1.08
	KEPCO Definite Normal Inverse	0.0515	0.02	0.114
Overvoltage(59)	Inverse	10.5	1.75	0.00
Undervoltage(27)	Inverse	8.0	2.2	0.00
Ground overvoltage(59G)	Trip Inverse	12.5	2	0.35
	Alarm Inverse	24.75	2.23	4.15

In the case of overcurrent protection element, operating time of current is equal with operating time of 2000% more than 2000% of setting current. In the case of overvoltage protection element, operating time of voltage is equal with operating time of 800% more than 800% of setting voltage.

- Thermal overload protection

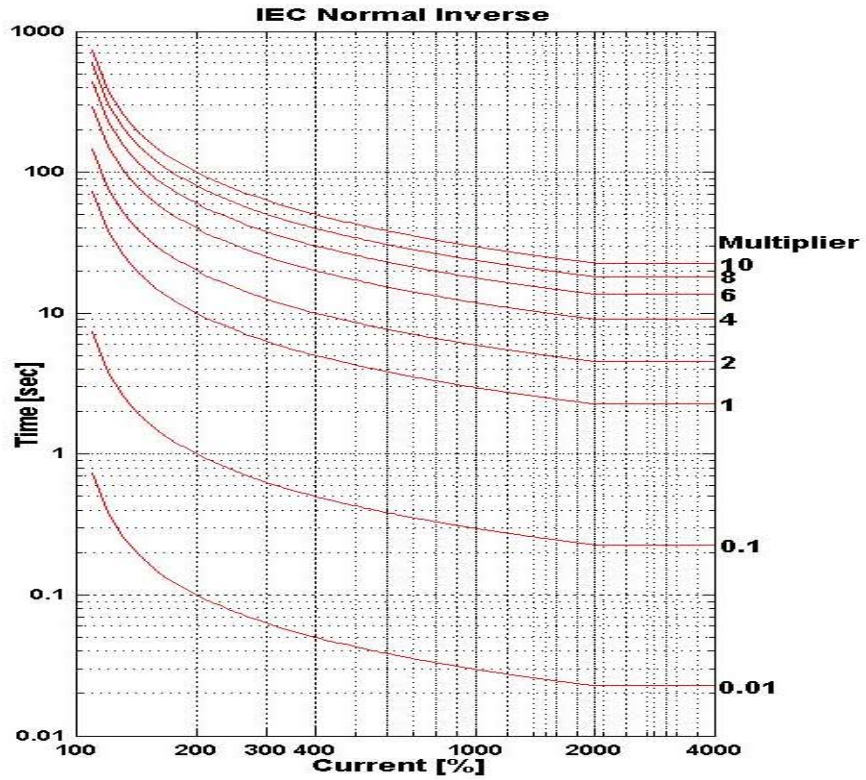
Hot State

$$t = \tau \cdot \ln \left(\frac{\left(\frac{I}{k \cdot I_N} \right)^2 - \left(\frac{I_P}{k \cdot I_N} \right)^2}{\left(\frac{I}{k \cdot I_N} \right)^2 - 1} \right) [\min]$$

Cold State

$$t = \tau \cdot \ln \left(\frac{\left(\frac{I}{k \cdot I_N} \right)^2}{\left(\frac{I}{k \cdot I_N} \right)^2 - 1} \right) [\min]$$

t : Operating time
τ : Time const
I : Current input
I_N : Rated current
Ip : Previous current
k : Overload ratio


IEC Normal Inverse
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100
10
1
0.1
0.01
Time [sec]
100
200
300 400
1000
2000
4000
Current [%]
Multiplier
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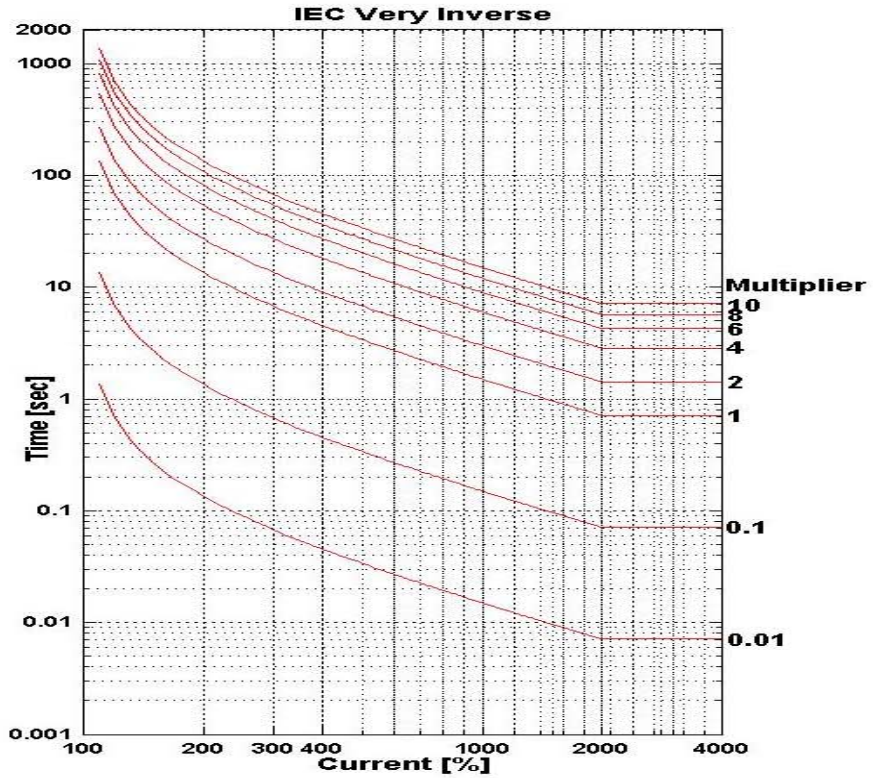
8
6
4
2
1
0.1
0.01


IEC Very Inverse
2000
1000
100
10
1
0.1
0.01
0.001
Time [sec]
100
200
300 400
1000
2000
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Current [%]
Multiplier
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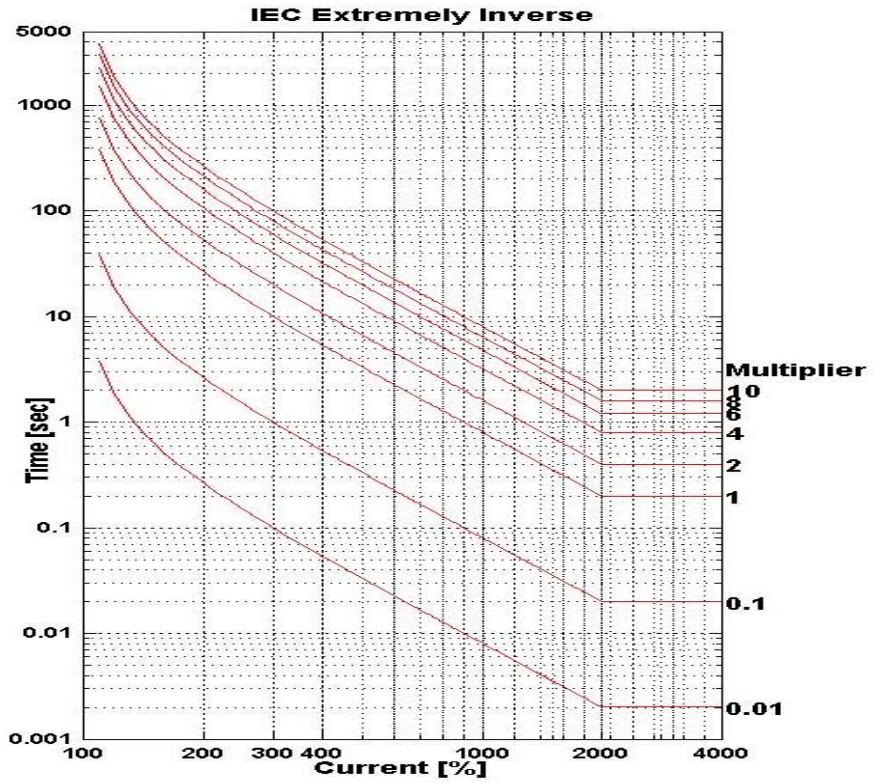
8
6
4
2
1
0.1
0.01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100
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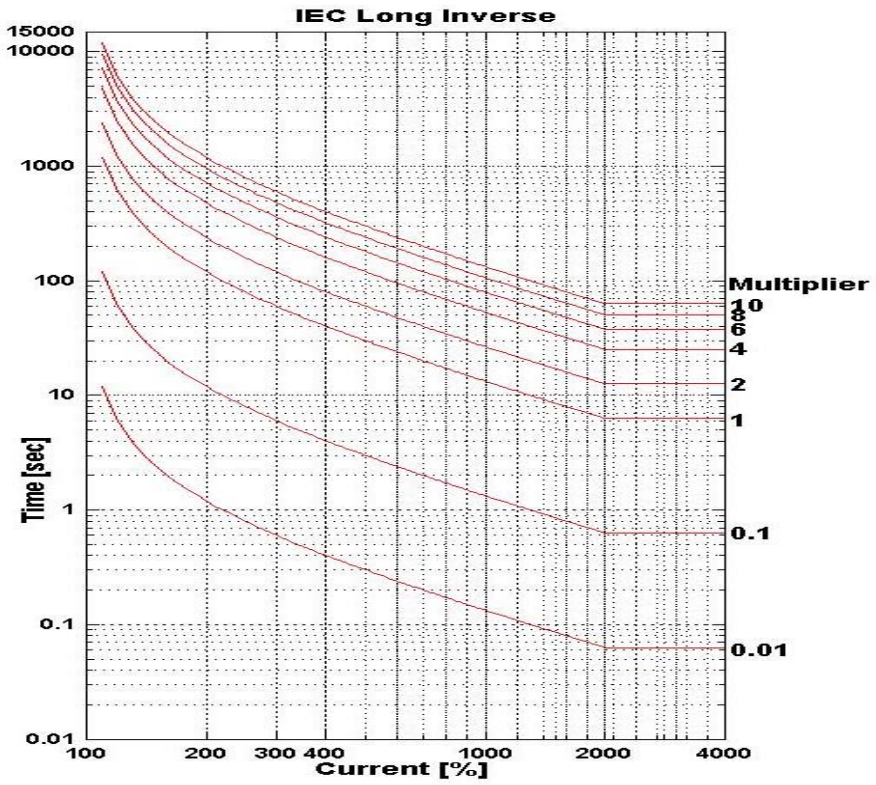
1
0.1
0.01
0.001
Time [sec]
100
200
300
400
1000
2000
4000
Current [%]
Multiplier
10
6
4
2
1
0.1
0.01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1000
100
10
1
0.1
0.01
Time [sec]
100
200
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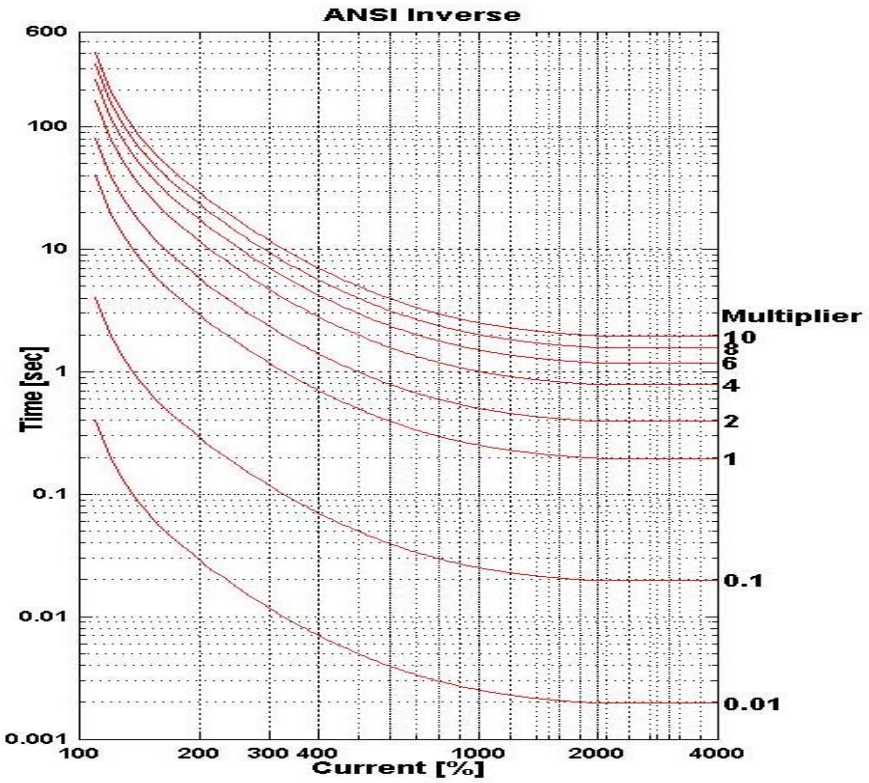
400
1000
2000
4000
Current [%]
Multiplier
10
6
4
2
1
0.1
0.01


ANSI Inverse
600
100
10
1
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0.01
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Time [sec]
100
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2000
4000
Current [%]
Multiplier
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8
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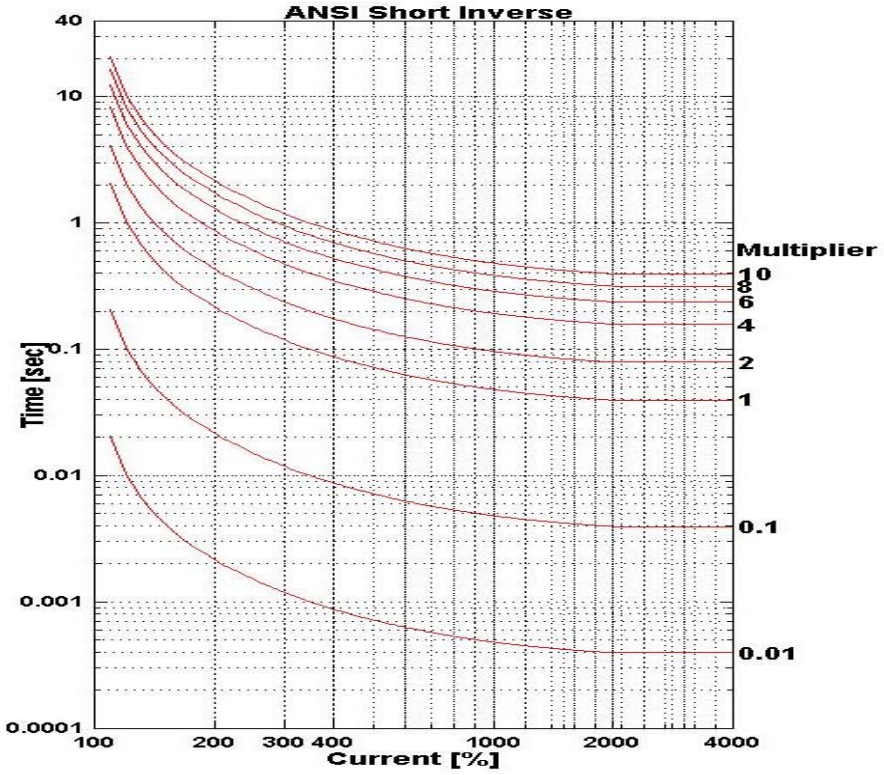
1
0.1
0.01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Current [%]
Multiplier
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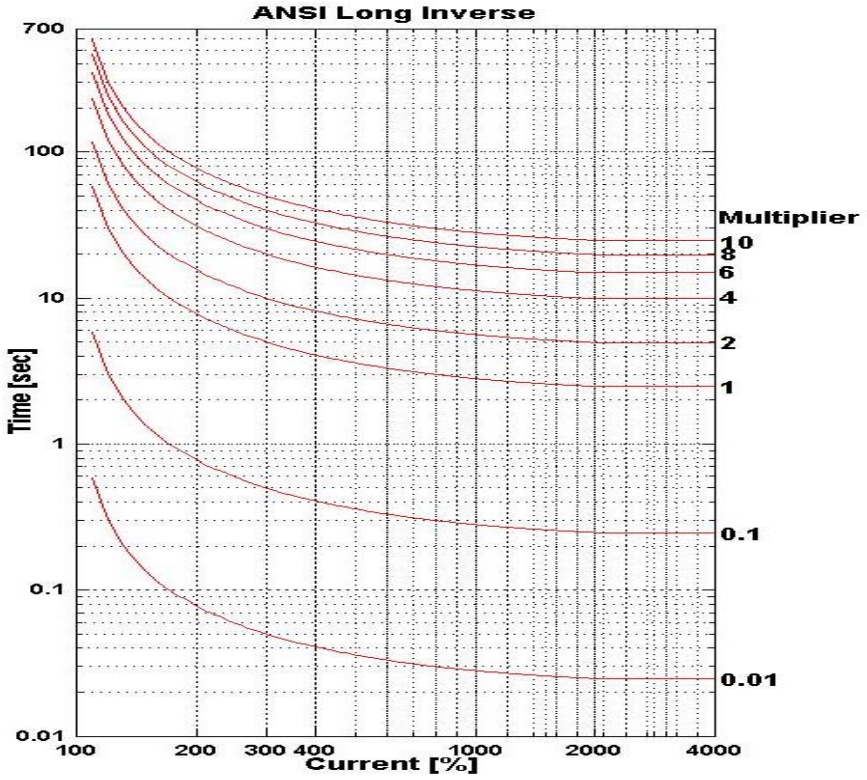
ANSI Long Inverse
700
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0.1
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Time [sec]
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Current [%]
Multiplier
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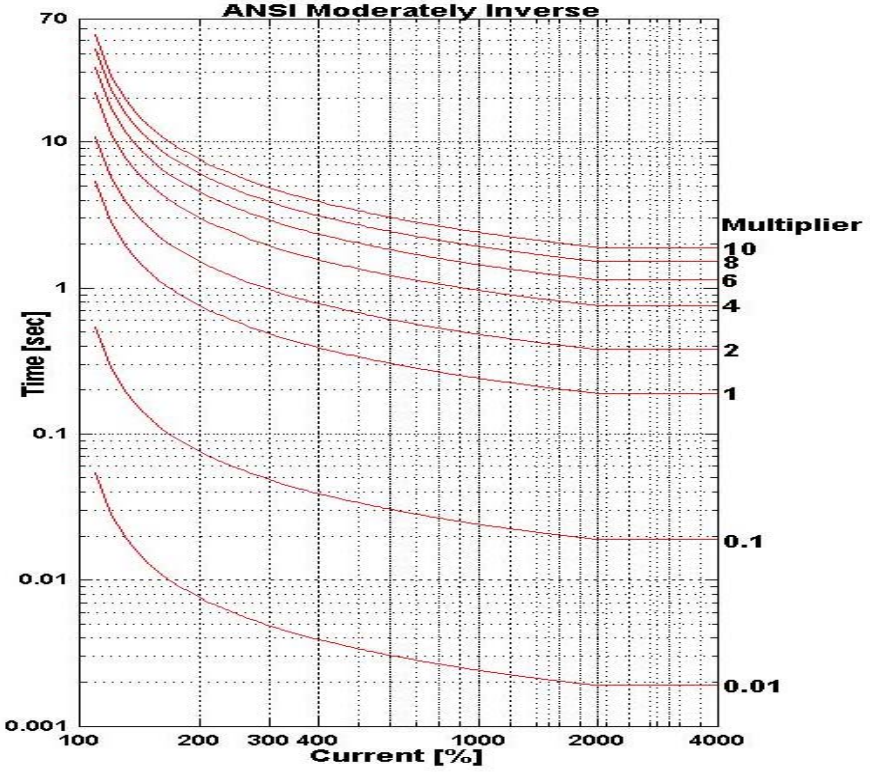
ANSI Moderately Inverse
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0.1
0.01
0.001
Time [sec]
100
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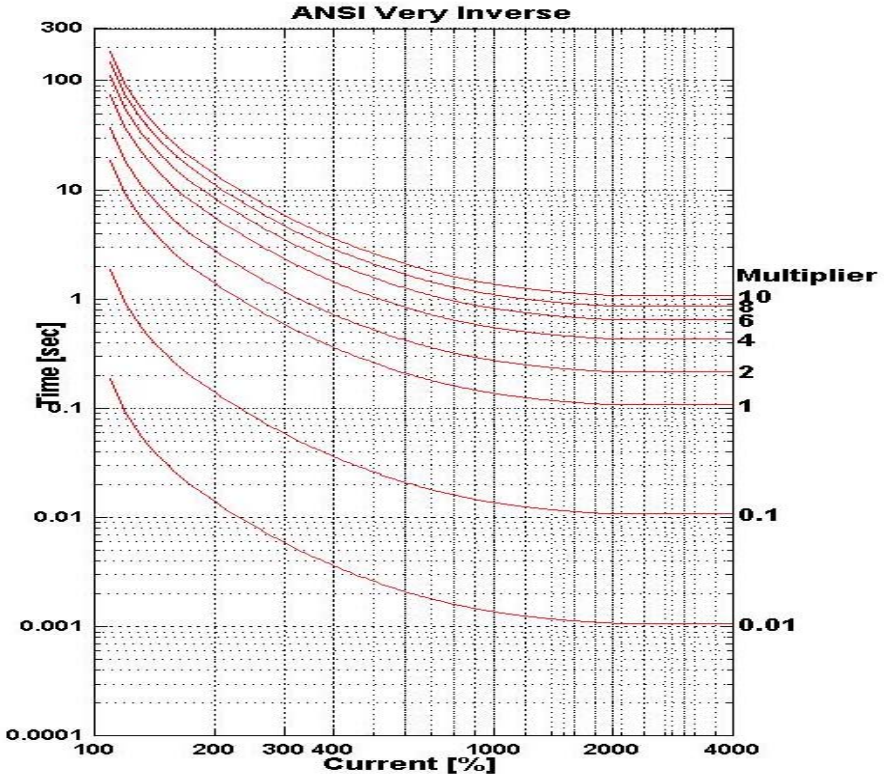
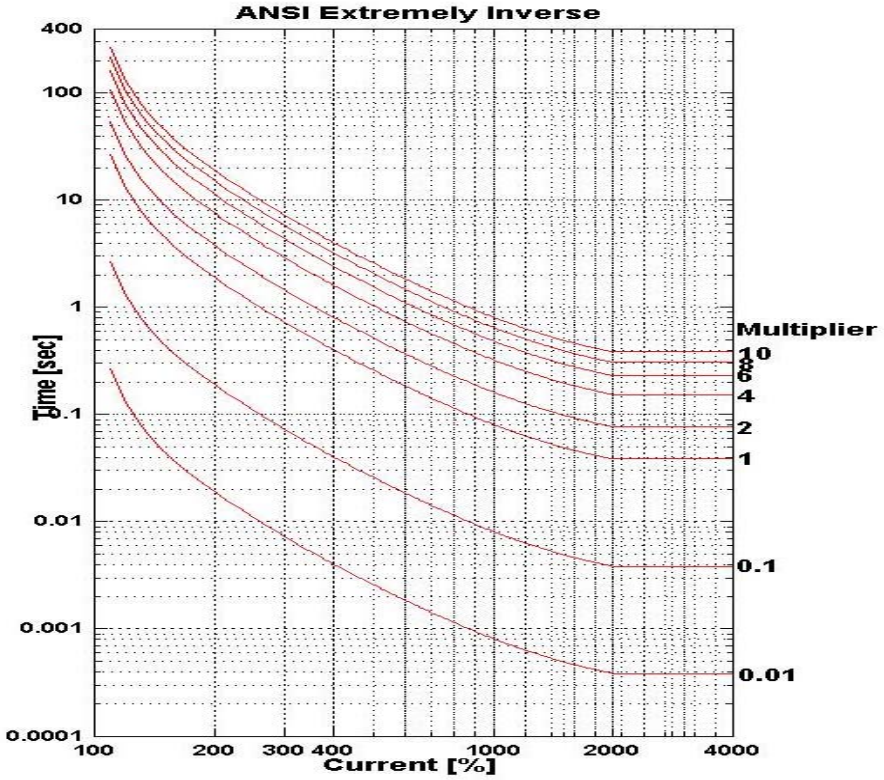
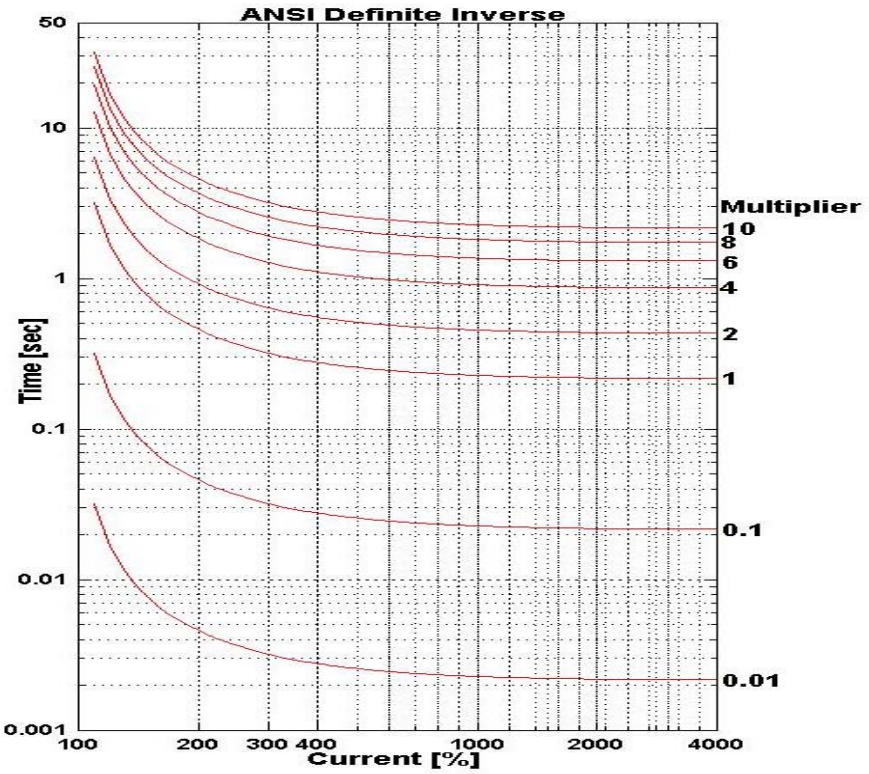
300 400
1000
2000
4000
Current [%]
Multiplier
10
8
6
4
2
1
0.1
0.01


ANSI Very Inverse
300
100
10
1
0.1
0.01
0.001
0.0001
Time [sec]
100
200
300
400
1000
2000
4000
Current [%]
Multiplier
10
6
4
2
1
0.1
0.01


ANSI Extremely Inverse
400
100
10
1
0.1
0.01
0.001
0.0001
Time [sec]
100
200
300
400
1000
2000
4000
Current [%]
Multiplier
10
6
4
2
1
0.1
0.01


ANSI Definite Inverse
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1
0.1
0.01
0.001
Time [sec]
100
200
300
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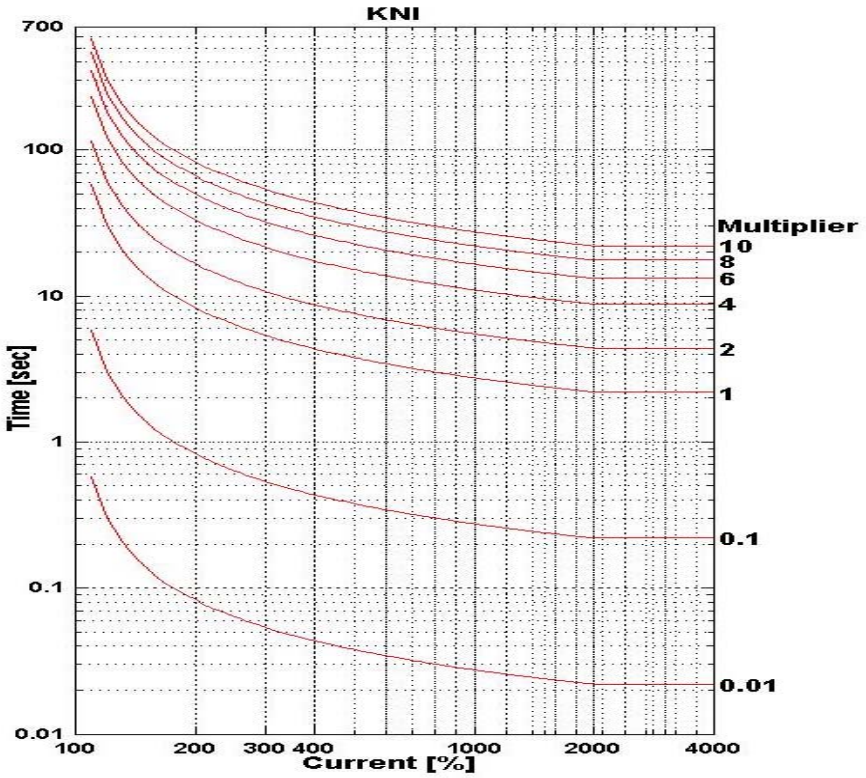
1000
2000
4000
Current [%]
Multiplier
10
8
6
4
2
1
0.1
0.01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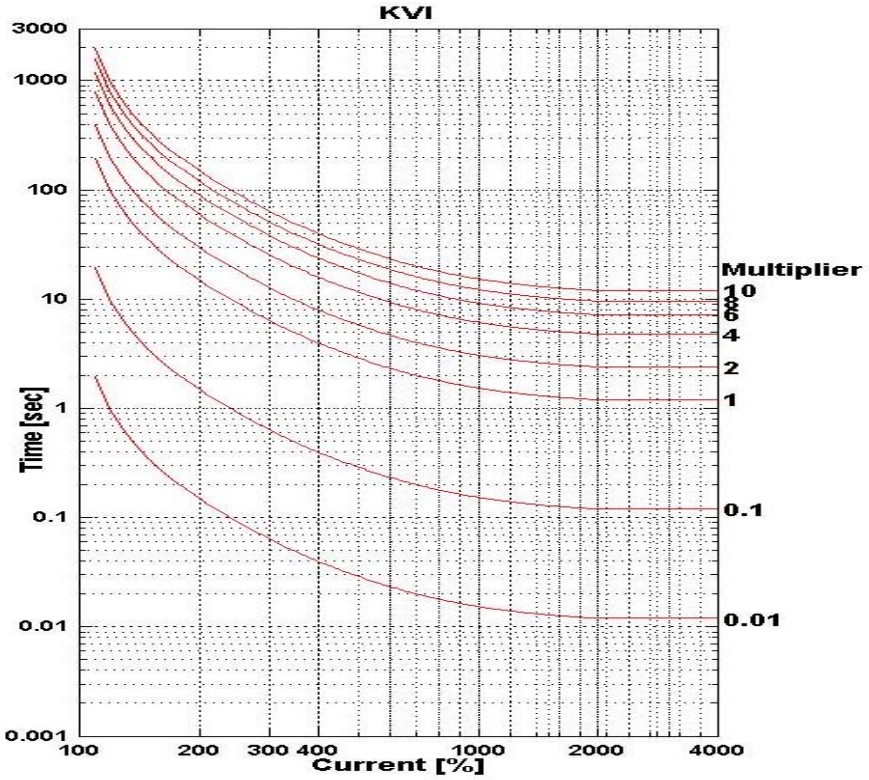
KVI
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Current [%]
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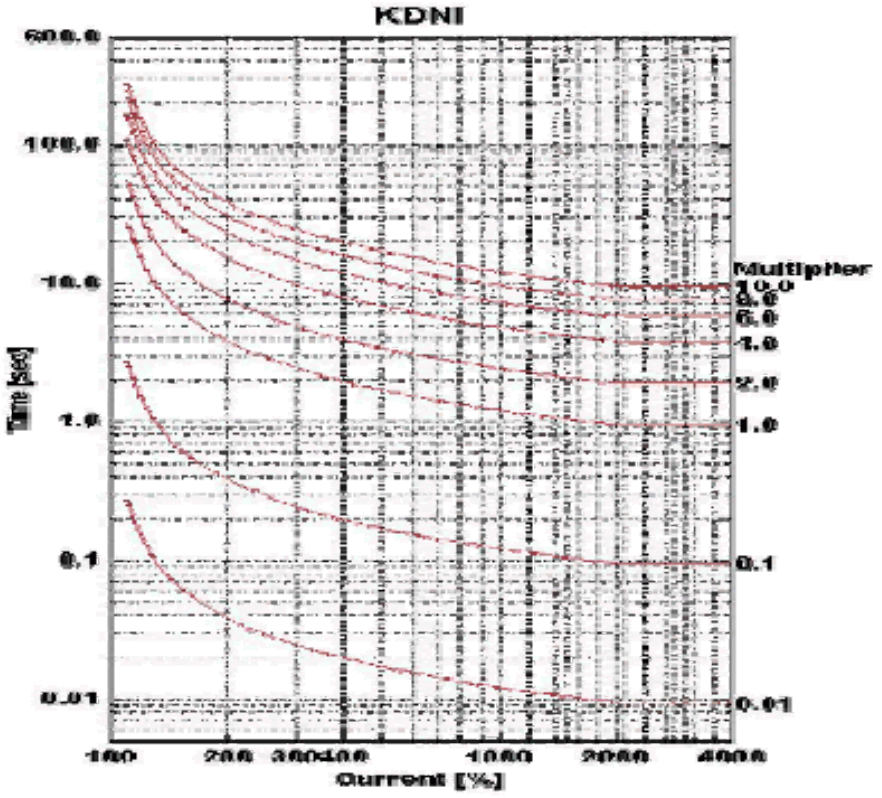
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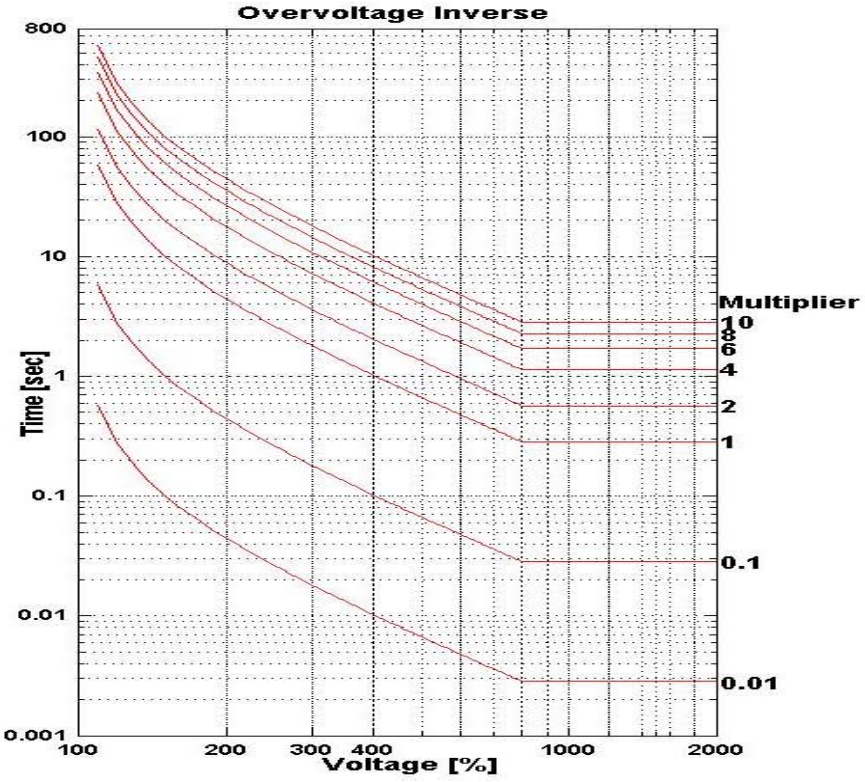
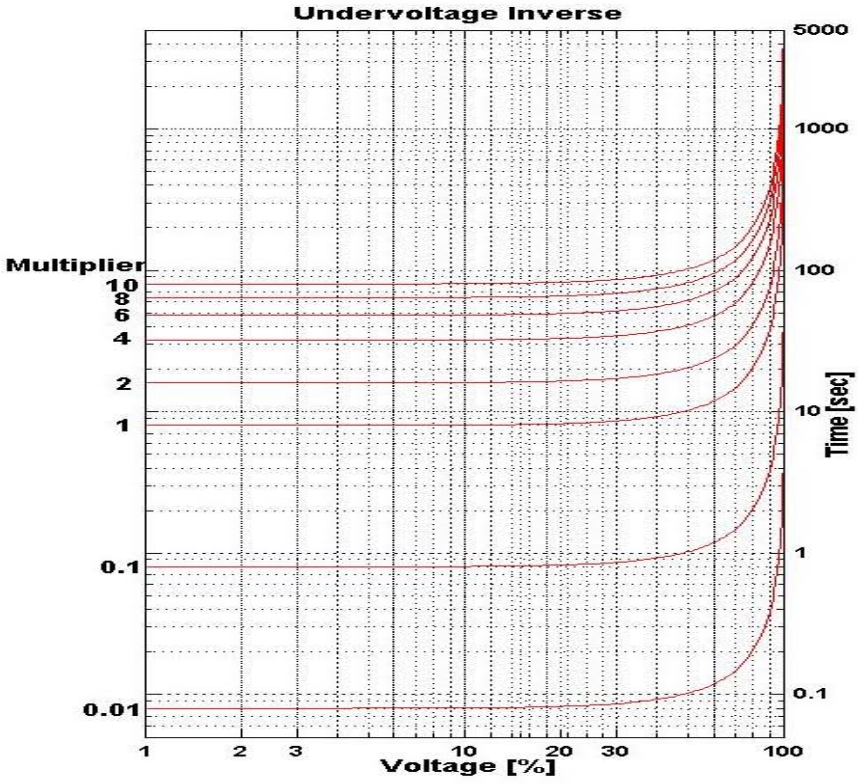
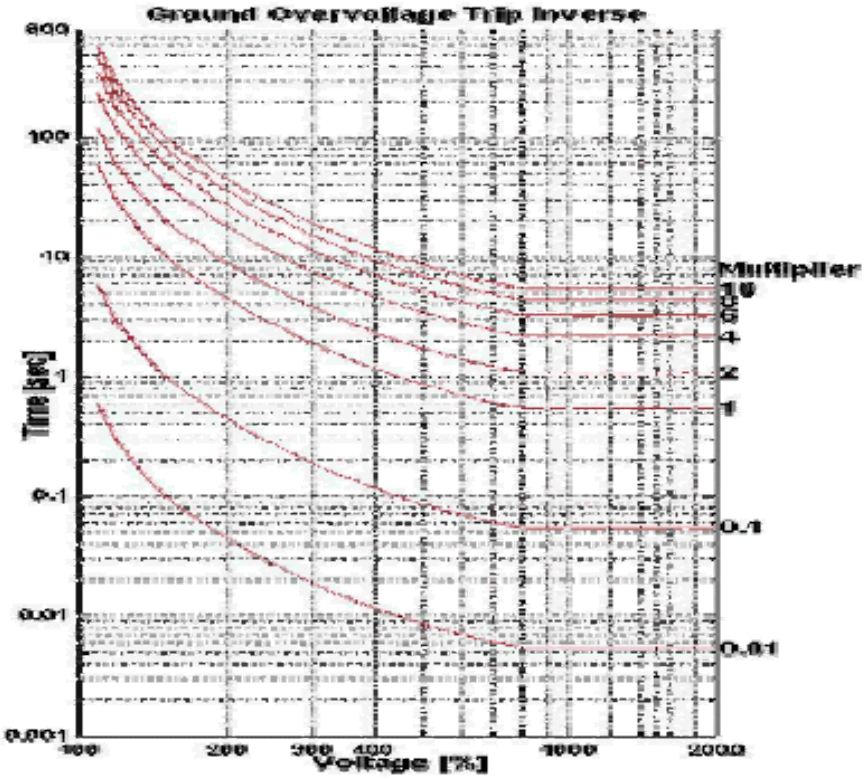
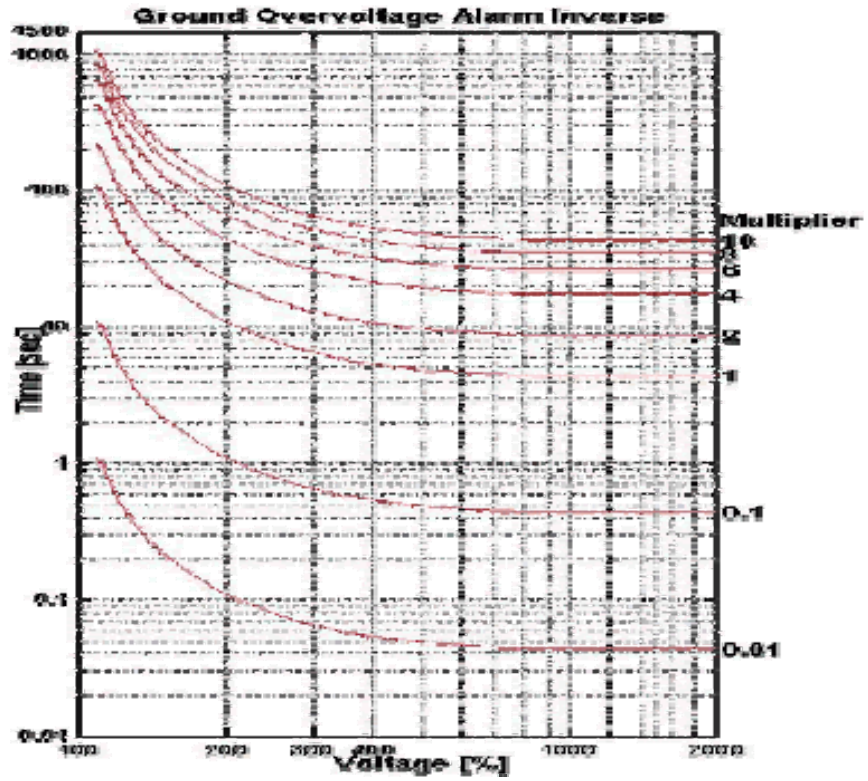
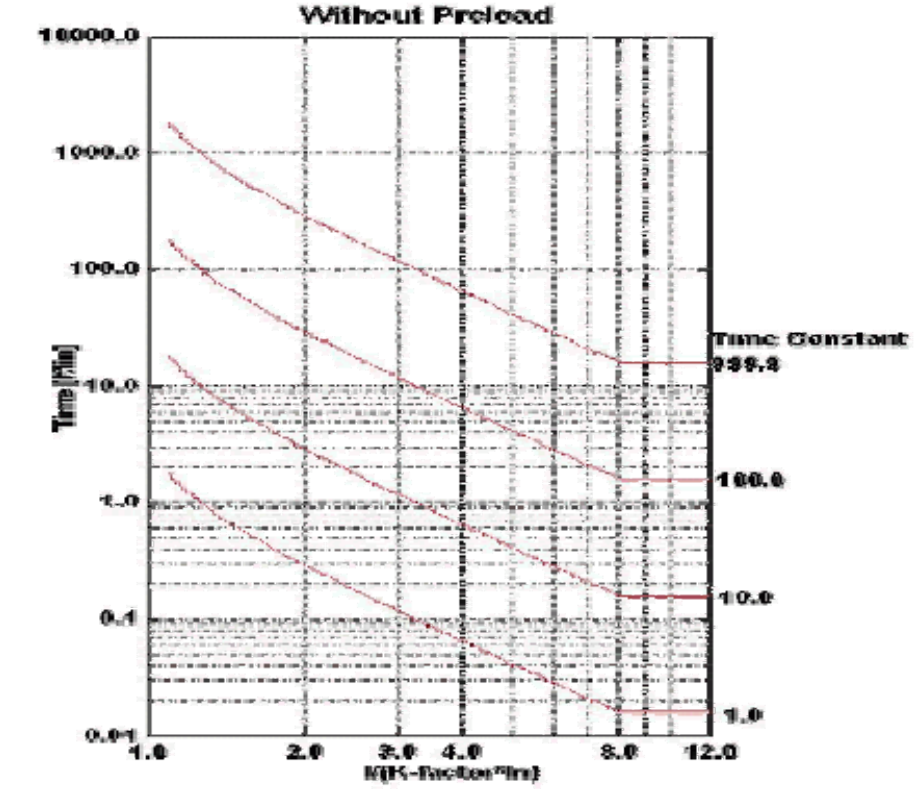
Multiplier
0.1
0.01

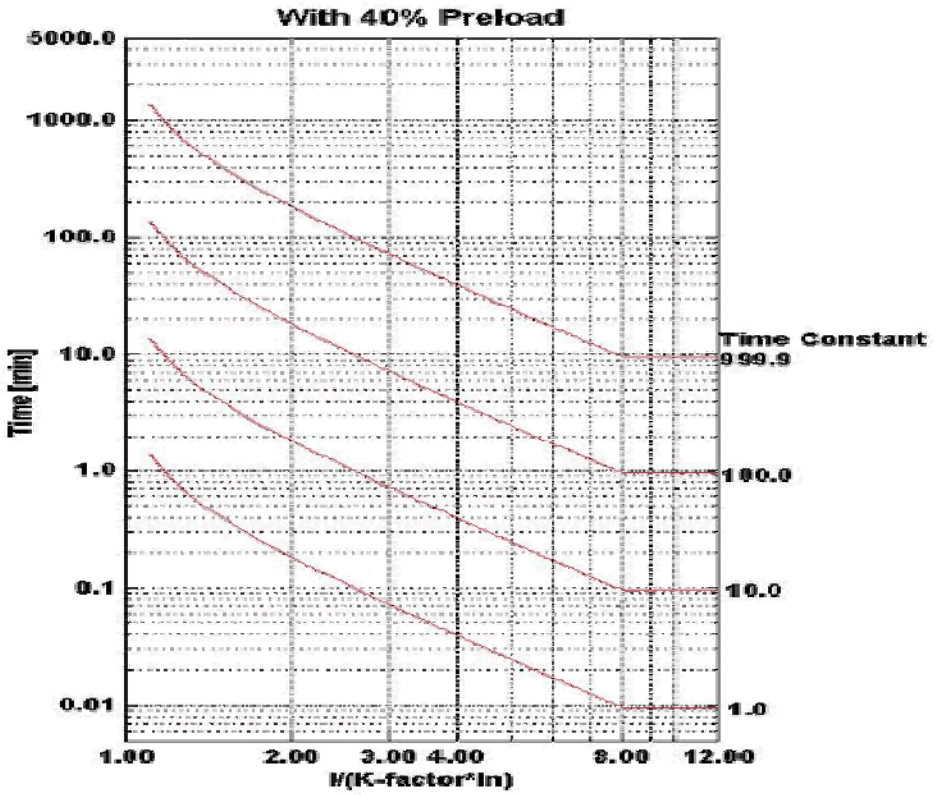

Overvoltage Inverse
800
100
10
1
0.1
0.01
0.001
Time [sec]
100
200
300
400
1000
2000
Voltage [%]
Multiplier
10
8
6
4
2
1
0.1
0.01


Undervoltage Inverse
5000
1000
100
10
1
0.1
0.01
Time [sec]
1
2
3
10
20
30
100
Voltage [%]
Multiplier
10
8
6
4
2
1
0.1
0.01


Ground Overvoltage Trip Inverse
Time [sec]
Voltage [%]
Multiplier
10
8
6
4
2
1
0.1
0.01


Ground Overvoltage Alarm Inverse
Time [sec]
Voltage [%]
Multiplier
10
8
6
4
2
1
0.1
0.01


Without Preload
10000.0
1000.0
100.0
10.0
1.0
0.1
0.01
Time [Min]
1.0
2.0
3.0
4.0
8.0
12.0
I/(K-factor*In)
Time Constant
999.9
100.0
10.0
1.0


With 40% Preload
5000.0
1000.0
100.0
10.0
1.0
0.1
0.01
Time [min]
1.00
2.00
3.00
4.00
8.00
12.00
I/(K-factor*In)
Time Constant
999.9
100.0
10.0
1.0

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